OBSTETRICS

·by Ten Teachers

under the direction of

STANLEY G. CLAYTON

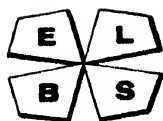M.D., M.S.(LONDON), F.R.C.S.(ENG.), F.R.C.O.G.

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PREFACE

SINCE the publication of the 10th edition of this book the death of Mr. Frederick Roques, the retirement of Mr. John Beattie and Mr. Joseph Wrigley from the editorship, and of Mr. Humphrey Arthure, Mr. C. M. Gwillim and Mr. Victor Lack from the staff of contributors have resulted in no less than six changes in the 'Ten Teachers'.

Mr. Roques had been a contributor for sixteen years and he directed the production of the last two editions. He constantly strove to secure an accurate and readable interpretation of the views expressed by his team, often tempering these with wise conservatism when untried ideas were brought forward.

We welcome as new contributors Mr. Donald Fraser, Mr. J. Holmes, Mr. Ian Jackson, Mr. George Pinker, Professor Philip Rhodes and Mr. D. W. Taylor Roberts.

One innovation that will be evident in this edition is the change of title from 'Midwifery' to 'Obstetrics'. Although we regret the loss of an English word the new title is more in keeping with current usage.

The whole text has been thoroughly revised, and no chapter is without some change. We have attempted to describe modern obstetric practice and to keep abreast of recent advances in theoretical knowledge. Although we have reduced the length of some of the chapters on major 'mechanical' complications of labour, which are now of less importance than formerly in Britain, we have not completely eliminated these sections because some of our readers practise in countries where adequate obstetric services are still not generally available.

We are grateful to Miss Mary Waldron for several new illustrations, and we especially thank our publishers for their patience.

CONTENTS

INTRODUCTION

MANY doctors find great satisfaction in the practice. of obstetrics. The aim of good obstetric practice is normality; prevention is as important as treatment. Conscientious work in the weeks of pregnancy has not only preserved, or even helped to improve, the health of the mother, but also it has succeeded in foreseeing and perhaps preventing many difficulties or even disasters that would have arisen in the subsequent labour or puerperium. The benefits provided thereby to the mother must have been multiplied many times in the case of the infant.

One factor in the great improvement in recent years in the figures for maternal and perinatal mortality is the greater skill of the doctors who practice obstetrics. For this there is more than one obstetrics, but it is probable that there is no item of greater importance than the emergence of a general appreciation by the medical profession itself of the wisdom of postgraduate experience in obstetrics before embarking on domiciliary practice. Such experience is gained by holding a resident obstetric post for a minimum period of six months.

If, therefore, only a proportion of doctors are to practice obstetrics why is it necessary to include a period of so thorough training in midwifery in the curriculum of every medical student? This question has been asked many times, for under half of all those who qualify will enter general practice. The answer is quite simple. Pregnancy and labour constitute two matters of the greatest importance in the physiology of women. No man or woman who was not familiar with the subject could pretend to understand their female patients. Apart from this, midwifery may demand immediate medical aid and every doctor must surely be expected to be able to render at least sensible first aid measures until expert assistance can be summoned.

Nearly all medical students enjoy their period of training in the midwifery wards. At once, and perhaps for the first time, they feel that they are indeed active members of a team. The obstetric training is able to give the student some responsibility and this, together with his interest, stimulates enthusiasm. The results of prenatal work rapidly become apparent and these are especially seen in the benefits that follow the care taken to maintain the mother's general state of health. In the labour wards the student is able to put into practice the principles of surgical technique which have hitherto been theoretical for the most part. The personal responsibility of the student for the mother and her baby does not end in

the labour ward for it should continue at least until they leave hospital to return home. The few days of in-patient stay not only allow the woman to recover from the ordeal of labour, which varies greatly, but what is more important they give her time to become accustomed to a new set of circumstances, i.e. the arrival of another and important member of the family and all that that means. The student will learn to appreciate, probably for the first time, the strength of the maternal instinct, and concurrently too often the complete ignorance of the husband of all that his wife has gone through or of the part he should play in trying to help her.

He will be able better to appreciate the skill and trials of the nursing staff with whom he works and will become familiar with the never ending activities of a hospital. Lastly, and perhaps it is due to enthusiasm, obstetrics teaching almost universally is of the highest standard. That it is practical—it must be—is immediately apparent and the student finds he rapidly acquires a working knowledge of the subject.

The midwifery curriculum lasts at least two months and during the first four weeks the student should aim at reading through one not too lengthy textbook from cover to cover. Many old terms and words have been retained and he should be familiar with their meaning.

Interest in medicine is furthered by some knowledge of its history and especially so is this the case in midwifery. In addition it is advisable that the student should have some knowledge of the conditions under which, if he decides to practise midwifery, he is likely to work. It is proposed therefore to give a very brief account of the evolution of the Midwifery Services of Britain. The history of the development of these services may have some interest and significance even for those who practice in countries in which such services are not yet available.

The art of midwifery has been practised in some form or another ever since the days of Adam and Eve and it is useful to remember, especially to those who have contact, and perhaps conflict, with that powerful and assertive body of women known as midwives, that the first 'midwife' must have been a man. Be this as it may, from that early date women took over the task of supervising the birth of babies. In this capacity they are mentioned six times in the book of Genesis and repeatedly throughout the Old Testament. The physician hardly enters the picture at all and then at a much later date. The surgeon is not mentioned.

Until the end of the last century, and indeed until the early years of the present one, the vast bulk of midwifery was done in the home. Nearly all confinements were domiciliary and nearly all babies were born under the care of an untrained or self-trained woman or midwife. There existed a few, very few, hospitals for maternity cases. They were usually called *lying-in hospitals* and were founded in the eighteenth century. For the

most part they catered for the abnormal case, but it must be remembered that until comparatively recent years communications and transport were slow and unreliable and therefore these few institutions could only possibly serve the needs of a minute, and local, fraction of the population. The same factors provided, for exactly similar reasons, a severe limit in the availability of the expert obstetrician. Such men existed and have existed ever since Soranus of Ephesus, who practised and wrote in the second century and is with some justification honoured with the title 'The First Obstetrician', but they were to be found only in the larger cities.

The extent, therefore, of domiciliary midwifery was such that every doctor had perforce to possess some knowledge of the art and indeed many practitioners became, usually by the hard route of bitter experience, extremely able obstetricians.

The midwife also was largely self-taught; much of her learning was handed down from mother to daughter, little or none came from books for the very obvious reasons that the books were few and almost certainly the midwives could not read. The practice of the midwife was further influenced by tradition, religion, superstition, mystery and the like. Descriptive accounts of these women, and of their medical colleagues, are both amusing and illuminating. They tell us something of the conditions under which our ancestors were born into this world. Let us relax for a few moments and read about Mrs. Elizabeth Nihell who was a midwife of the old school and who obviously did not like doctors. In 1760 she published a *Treatise on the Art of Midwifery*. In it doctors are called 'he-practicers' and are referred to as 'those self-constituted men-midwives made out of broken barbers, tailors or even pork-butchers, for I know one myself of this last trade, who after passing half his life stuffing sausages is turned an intrepid physician and man-midwife. See the whole pack open in full cry. To arms! To arms! is the word and what are those arms by which they maintain themselves but those instruments (the obstetric forceps) those weapons of death!' The first part of Tristram Shandy is full of it all and Sterne described the prolonged argument between Mrs. Shandy, whose baby was to be born in the country and who was all for a midwife, and her husband who desired the attention of a doctor described as 'a scientific operator within so near a call as eight miles of us and who moreover had expressly wrote a five shilling book upon the subject of midwifery'. In the end Dr. Slop arrives and gives a demonstration of the forceps on Uncle Toby's fist, somewhat to its detriment. 'Upon my honour Sir, you have tore every bit of skin quite off the back of both my hands with your forceps and you have crushed all my knuckles into the bargain with them to a jelly.' Subsequently the midwife was able to report Tristram's birth thus: 'In bringing him into the world with his vile instruments he has crushed his nose flat as a pancake to his face, and he is

making a false bridge with a piece of cotton and a thin piece of whalebone out of Susannah's stays to raise it up.'

Such was the state of affairs in the world of midwifery certainly up to the end of the eighteenth century and for practical purposes until roughly fifty years ago. It is often said that it is a British characteristic to proceed by slow evolution and to build up our institutions and services by trial and error. The progress of the Maternity Services in Britain can best be described in chronological order as follows:

1726. The first Chair of Midwifery founded in Scotland for *the training of Midwives.*

1807. The Obstetric Society of London granted a diploma *to midwives.*

1881. The Midwives Institute was founded to raise the efficiency and improve the status *of midwives.* Sixty years later it became the College of Midwives and subsequently was granted a Royal Charter.

1886. For the first time Obstetrics was made compulsory in the training of doctors. This was largely due to a prolonged and energetic campaign conducted by the Worshipful Society of Apothecaries of the City of London.

1902. The Midwives Act was passed and the Central Midwives Board created. This was a great step forward and secured the certification of midwives in England and Wales.

1918. The Maternity and Child Welfare Act empowered Local Authorities to provide Antenatal Clinics. Such a service had been started earlier in several teaching hospitals and the value of antenatal care was rapidly assessed by the Local Authorities.

.   Foundation of the College of Obstetricians and Gynæcologists. Later granted a Royal Charter.

.   Foundation of the National Health Service.

At this time by a process of 'evolution' a woman in her pregnancy might find herself in the care of at least five separate people or authorities:

1. Her own doctor who might not practise obstetrics.
2. Another general practitioner who did practise obstetrics.
3. Her midwife.
4. Her antenatal care might be the responsibility of the doctor or midwife at the Local Health Authority Clinic.
5. She was often referred to a Hospital Clinic for an 'expert opinion' from an obstetric consultant.

Most women were the part responsibility in their confinement of three people and all of two. This state of affairs might not matter, indeed it could have been to her benefit, if the various services worked together as one co-ordinated unit. It was hoped that the institution of the National Health Service might have brought this about, especially as it had been so

strongly advised by the Royal College of Obstetricians and Gynæcologists in 1947. But this did not happen. The co-operation between the various parts of the Maternity Service will be found to be most variable and in many areas there seems to exist between these components what can only be described as an unhealthy rivalry. Individually each branch has done and is doing magnificent work, the value and results of which are demonstrable in the steady improvement in the figures published annually by the Ministry of Health of the maternal and perinatal mortality rates. Collectively, and with a minimum of direction, how very much more could be achieved.

History could show us many other aspects of obstetrics, such as the fascinating story of Cæsarean section, or of the discovery by Chamberlen in England of the obstetric forceps, or of the use of anæsthetics in childbirth, or of the design of destructive instruments to assist in the delivery of the child, or of the introduction of and changes in antenatal care, but space does not allow more than their mention. The student can look forward to such reading later when it will help him to balance his knowledge and to show that while much has been achieved a great deal remains to be done.

OVULATION, MENSTRUATION, FERTILIZATION AND EMBEDDING OF THE OVUM

IN health, throughout the years between puberty and the menopause, the lining of the body of the uterus is shed and discharged together with some blood through the cervix and vagina at fairly regular intervals of about one month. This external menstrual discharge is the outward sign of the activity of the reproductive hormones, which cause the release of an ovum from the ovary in each cycle, and control the cyclical changes which occur in the uterus, the lower genital tract and the breasts. The cycle is commonly of 28 days, but few women are precisely regular, and cycles of between 21 and 35 days may be accepted as being within normal limits. It is customary to describe these changes by counting from the first day of menstruation.

In normal cycles ovulation occurs about 14 days before the onset of the next period. In a 28-day cycle this is midway between menstrual periods, but there is considerable variation in this. Ovulation, which refers to the release of the ovum from the surface of the ovary into the peritoneal cavity, is preceded by the growth of the ovarian follicle (Graafian follicle), as will be described in more detail in the next section. After ovulation the follicle from which the ovum has been extruded becomes the corpus luteum. These cyclical changes in the ovary are brought about by the action of hormones secreted by the anterior lobe of the pituitary gland. These pituitary gonadotrophic hormones cause ripening of the Graafian follicle and ovulation, and also the subsequent formation and maintenance of the corpus luteum. The cells of the follicle and of the corpus luteum secrete œstrogen and progesterone, and these hormones in their turn bring about the cyclical changes in the endometrium.

Under the influence of these ovarian hormones the endometrium reaches its maximal development in the late part of the menstrual cycle, so that if the ovum liberated at mid-cycle is fertilized and carried down the Fallopian tube it will reach the cavity of the uterus when the endometrium is thick and hyperæmic, forming a prepared bed into which the fertilized ovum (zygote) can burrow and continue its development.

If the ovum in a particular cycle is not fertilized the activity of the corpus luteum ceases after a few days, so that the production of œstrogen and progesterone stops, and then the endometrium except for its basal layer breaks down and is discharged in the menstrual lochia. On the other hand,
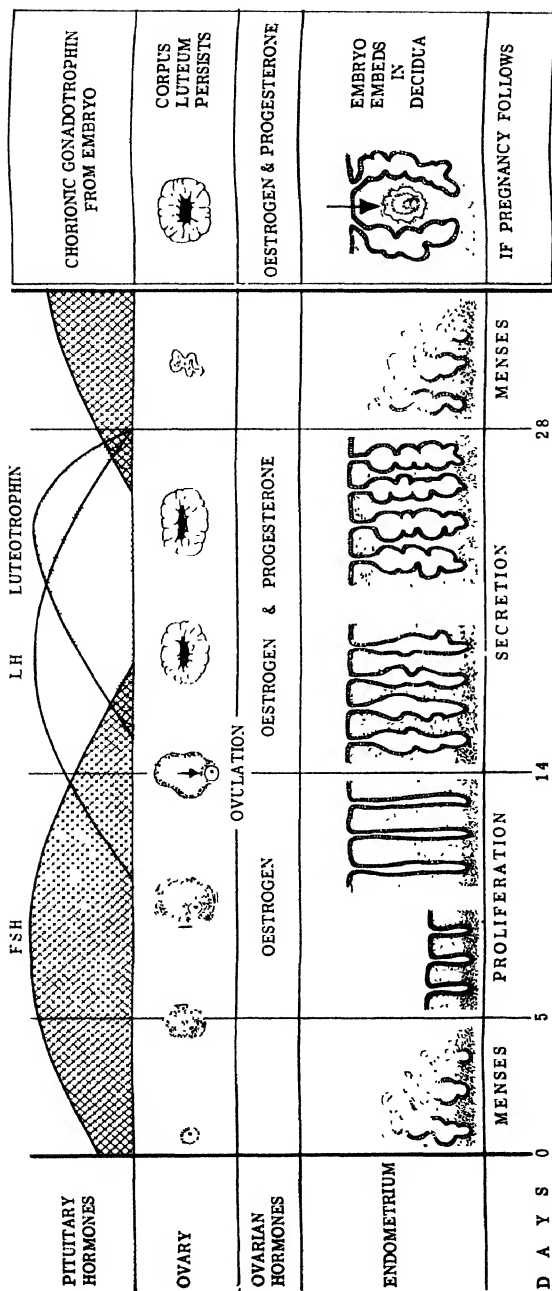
Fig. 1.

if the ovum is fertilized some of its chorionic cells produce another gonado-trophic hormone (chorionic gonadotrophin) which maintains the activity of the corpus luteum for a time. In addition the chorionic cells themselves produce œstrogen and progesterone in steadily increasing amounts. Thus, during pregnancy, œstrogen and progesterone, coming either from the ovary or from the chorionic cells of the zygote, maintain and carry on the growth of the endometrium, which is now described as the decidua of pregnancy, and the amenorrhœa of pregnancy follows instead of the menstrual periods.

OVULATION

In the human embryo, at as early as the 4th week of life, part of the cœlomic epithelium becomes thickened, and the cells in it proliferate and bud down into the underlying mesenchyme. This area was originally described as the germinal epithelium because it was thought that the primitive germ cells were derived from it. It is now known that germ cells migrate by amœboid activity into this area from the wall of the yolk sac, and
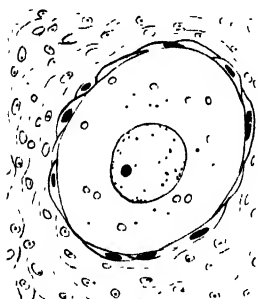

FIG. 2.   Primordial follicle.

these invading cells form the primordial germ cells, some of which proliferate to give rise to numerous primary oöcytes. The oöcyte is a large round cell, with a relatively large nucleus that is rich in chromatin. The primary oöcytes become surrounded by a single layer of smaller flattened cells which are derived from the germinal epithelium. Each such system, consisting of an oöcyte and the surrounding flattened cells, is described as a primordial (Graafian) follicle, and at birth the human ovary contains more than 100,000 follicles. It is not certain if any of these primordial ova survive to mature after puberty. At one time it was held that all functioning ova were derived from this large store of primor-dial ova, and that no other ova developed after fœtal life, but it is now thought to be more likely that the ova which mature after puberty are of more recent development from the germinal epithelium. It is certain that human ovarian germinal epithelial cells will form ova on tissue culture. Whatever the origin of the functioning ova may prove to be, throughout the reproductive years some of the follicles ripen and ovulate.

In each menstrual cycle several follicles start to mature, but for some reason that is not understood one outstrips the others, and in most cycles only one follicle reaches full development, although some cases of multiple pregnancy are due to ripening and fertilization of more than one ovum

in one cycle. During maturation of the follicle the flat cells that surround the primordial ovum multiply and become rounded and arranged in several layers. These cells are now called granulosa cells. Their growth is eccentric, so that the ovum comes to lie at one side of the mass of granulosa cells, and eventually a clear albuminous fluid appears among these cells, so that a follicle is formed with the ovum placed to one side of this. (See Figs. 3 and 4.) The clump of granulosa cells that is directly related to the ovum

FIG. 3.   Graafian follicle at the beginning of maturation.
A, Ovum. B, membrana granulosa. C, liquor folliculi.

forms a hillock (the discus proligerus) that projects into the cavity of the follicle, and at this stage the ovum is seen to be surrounded by a clear elastic membrane, the zona pellucida, within which it can rotate. The granulosa cells that are immediately related to the zona pellucida become arranged in a radial fashion, and are therefore described as the corona radiata. The ovum itself grows slowly during the maturation of the follicle, chiefly by increase in the volume of the cytoplasm, and reaches a diameter of about 0·13 mm.

The cells of the ovarian stroma which surround the granulosa cells also

proliferate and become swollen by the accumulation of lipoid. These cells form the theca interna, and play an important part in the formation of the corpus luteum at a later stage. The ovarian stroma cells outside the theca interna become somewhat compressed by the growth of the follicle, and form the theca externa. (See Fig. 4.)

As the Graafian follicle increases in size it approaches the surface of the ovary, where it is seen as a transparent vesicle which varies in size, but
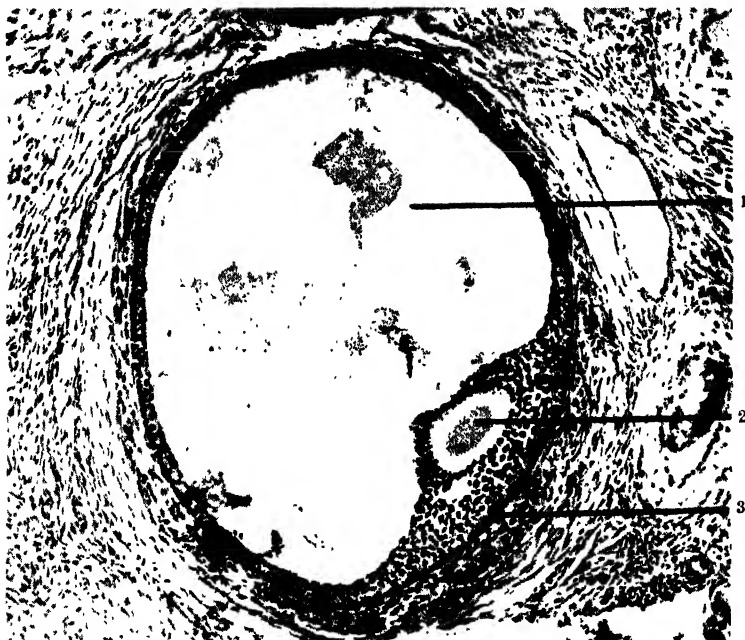
FIG. 4.   Ripe Graafian follicle.
1, Liquor folliculi. 2, ovum. 3, granulosa cells.

may reach a diameter of 10 mm. The follicle eventually projects from the surface of the ovary, through which it finally ruptures, and the gush of escaping follicular fluid carries the ovum, still surrounded by the cells of the corona radiata, into the peritoneal cavity.

The time of ovulation in women in relation to the menstrual cycle has been estimated from observations made on the ovaries at laparotomy, by direct recovery of ova from the Fallopian tubes at operation, and from indirect methods such as observations of changes in the basal body temperature. (See *Diseases of Women* by Ten Teachers.) Although ovulation most commonly occurs between the 12th and 15th day of the cycle, there is considerable variation in healthy women, and it is far from rare for

ovulation to take place as early as the 7th or as late as the 20th day. This fact is of importance in determining the duration of pregnancy. (See p. 58.) Ovulation has a closer time relation to the expected (following) period than to the preceding period; or in other words, there is more variation in the length of the part of the mentrual cycle that precedes ovulation than in the length of the part that follows it.

Ovulation is normally a spontaneous process controlled by the gonado-trophic hormones of the pituitary gland, but it is possible that its timing may be altered by other influences. In some mammals ovulation is initiated by coitus, and it is possible that coitus, particularly when attended with a strong emotional reaction, may occasionally have this effect in women. This might explain the fact that at all stages of the cycle pregnancy some-times appears to have followed a single coitus. The alternative explanation that either the ovum or sperms may survive for some time in the genital tract is less acceptable, and the available evidence suggests that unless the ovum is fertilized within 48 hours after ovulation it will not survive, and sperms do not appear to retain their activity for long.

CORPUS LUTEUM

After ovulation the walls of the Graafian follicle collapse and are thrown into folds, and there is usually a little hæmorrhage into the empty cavity. The granulosa cells become swollen by the accumulation of yellow lipoid,
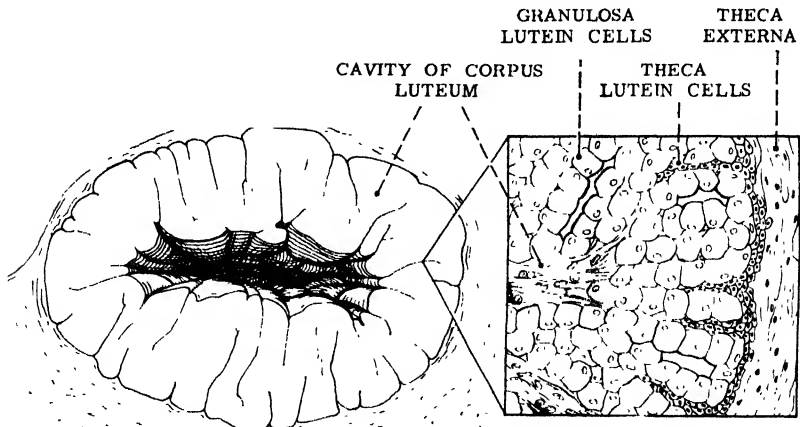

FIG. 5.   Corpus luteum.

and are now termed granulosa-lutein cells, while similar changes occur in the cells of the theca interna and these are now termed theca-lutein cells. (See Fig. 5.) The central coagulum soon becomes organized by the invasion

of capillaries. The mature corpus luteum is bright yellow in colour and is usually larger than the follicle from which it developed, reaching a diameter of 1 to 3 cm. If the ovum that was discharged from the follicle is not fertilized then degenerative changes begin in the corpus luteum at about the 22nd day of the cycle. By the time that the menstrual period begins the luteal cells show fatty degeneration, and ultimately the cells lose their outlines and nuclei. During subsequent weeks the whole structure becomes replaced by white connective tissue, and is then described as a corpus albicans. The corpus albicans is eventually absorbed, and finally the site of the follicle is only represented by a small scar.

On the other hand, if the ovum from the follicle is fertilized and pregnancy follows then the corpus luteum persists and enlarges further, maintaining its activity for about 12 weeks.

HORMONES CONTROLLING THE GROWTH AND ACTIVITY OF THE FOLLICLE AND CORPUS LUTEUM

Gonadotrophic hormones from the anterior lobe of the pituitary gland control the ripening of the ovarian follicle, ovulation, and the formation and maintenance of the corpus luteum. Three separate actions have been recognized by animal experiments, but it is still uncertain whether these different effects are produced by three separate hormones, or by a single hormone acting under different conditions and in different concentrations. It is generally held that there are three separate substances.

Follicle stimulating hormone (FSH) converts a primordial follicle into a ripe Graafian follicle. For ovulation to take place small amounts of a second hormone are required, and later in the cycle larger amounts of this second hormone are responsible for the formation of the corpus luteum. It is therefore known as *luteinizing hormone* (LH).[1] This hormone, LH, stimulates the maturing follicle, and later the corpus luteum, to secrete œstrogen, which in turn inhibits the production of FSH by the pituitary and stimulates the production of increasing amounts of LH. Thus ovulation is due to a balance between a rising concentration of LH and a falling concentration of FSH. As well as inhibiting the secretion of FSH and stimulating the production of LH, œstrogen stimulates the pituitary to produce a third hormone *luteotrophin*[2] after ovulation. Luteotrophin is responsible for the maintenance of the corpus luteum and causes it to secrete both œstrogen and progesterone. Progesterone inhibits the further production of LH.

If the ovum that is liberated in a particular cycle is fertilized its chorionic

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[1] This hormone is sometimes called Interstitial Cell Stimulating Hormone (I.C.S.H.).

[2] Luteotrophin is probably identical with prolactin.

cells secrete another gonadotrophic hormone known as *chorionic gonado-trophin*. The chorionic cells also secrete œstrogen and progesterone. The chorionic gonadotrophin is thought to be responsible for the prolongation of the activity of the corpus luteum during pregnancy.

MENSTRUATION; THE ENDOMETRIAL CYCLE

In this account we are chiefly concerned with the endometrial changes that are preparatory to the reception of the fertilized ovum; other details may be found in gynæcological textbooks. The number of days during which the menstrual flow persists varies in different women and from time to time in the same woman, but 4 to 5 days is the commonest time. The amount of blood lost varies between 10 and 60 ml. The period of time from the first day of one menstrual period to the first day of the next constitutes the menstrual cycle. We have already noted that the cycles are seldom precisely regular, and the duration of the cycle varies from woman to woman, but 28 days is the commonest cycle observed. The cycle consists of two phases, and it is customary to describe these by counting from the first day of the menstrual flow. The follicular (proliferative) phase starts on the first day of the cycle and lasts until the time of ovulation, when it is followed by the progestational (secretory) phase. (See Fig. 1.)

During the *follicular phase* the ovarian follicle is ripening, and its granulosa cells are secreting œstrogen. Soon after the end of the menstrual flow the endometrium is thin and consists of short straight tubular glands set in a scanty stroma. Under the influence of œstrogen the endometrium becomes more vascular, and the cells of the glandular epithelium and stroma both proliferate, so that the endometrium becomes thicker, with elongation of the straight gland tubules.

In the second *progestational phase* the cells of the corpus luteum secrete both œstrogen and progesterone, and these hormones acting together cause further growth of the endometrium with secretory changes that end with the onset of the next period. During this phase the gland cells become very tall and columnar, and pour out their secretion containing glycogen and mucin into the lumina of the glands. As a result of the epithelial hyperplasia and the accumulation of secretion the glands become tortuous and convoluted, so that in a section they appear to have crenated and irregular margins. These changes do not affect the very deepest parts of the glands, nor the superficial parts adjacent to the uterine cavity, so that there is a great contrast between the basal layer of straight glands, the spongy intermediate layer of distended and convoluted glands, and the superficial compact layer with straight glands. The cells of the interglandular stroma become greatly swollen, chiefly by increase of cytoplasm. This alteration is greatest in the superficial layer of the endometrium, and accounts for

the compact layer at the surface where the glands are compressed and straight, in contrast to the distended glands of the spongy layer. The arterioles are arranged spirally round the glands, and the whole endometrium becomes more vascular. All these changes are in preparation for the reception of the fertilized ovum. If the ovum is fertilized and embeds itself in the endometrium these changes in the endometrium persist and are accentuated, and the greatly thickened endometrium is now called the decidua of pregnancy.
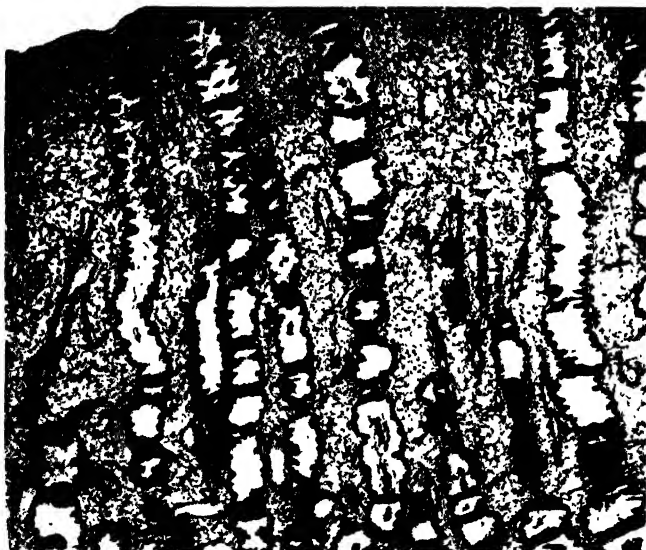

Fig. 6.   Photomicrograph of endometrium at the end of the secretory or progestational phase of the menstrual cycle.

If pregnancy does not occur the menstrual flow begins on the 28th day, and is brought about by spasm of the coiled arterioles, which cuts off the blood-flow and causes ischæmic necrosis of the endometrium except for the basal layer. The endometrium shrinks and the arterioles buckle, and with relaxation of the vascular spasm the disintegrated endometrium is shed into the uterine cavity with some bleeding. At the end of the menstrual period regeneration of the endometrium takes place from the residual basal layer, and the next menstrual cycle begins.

MATURATION OF THE OVUM

The nuclei of human body cells each contain 46 chromosomes, and this number is maintained throughout successive divisions of the cells. The chromosomes are responsible for the transmission of all the inheritable

qualities. The reproductive cells, the ovum and the spermatozoon, differ from the ordinary body cells in that they each contain only 23 chromosomes. When fertilization occurs and the ovum and spermatozoon unite the total of 46 chromosomes is re-established, the male and female cell each contributing half of the total, so that some inherited qualities are derived from the father and some from the mother. The number of chromosomes in the germ cells is reduced during the maturation of the cells by a special type of mitosis (called meiosis). In ordinary mitosis of body cells each chromosome divides into two, and the two halves of each chromosome separate and pass into the two daughter cells. In the reducing divisions of germ cells the chromosomes first become arranged in pairs, and then one member of each pair passes to each daughter cell, so halving the number of chromosomes in the mature germ cells.

In the case of the ovum the first maturation division occurs at the stage when the ovum is still in the ovary. The primary oöcyte divides into two cells of unequal size, a large secondary oöcyte and a small polar body. The polar body comes to lie in the perivitelline space within the zona pellucida. After this division the secondary oöcyte still contains the full number of chromsomes, but during the second maturation division, which takes place in the Fallopian tube, a second polar body is extruded, but in this division the number of chromosomes is reduced to 23, half of the chromosomes passing to the second polar body, and half remaining in the mature ovum. The polar bodies have no evident further function.

In the case of the spermatozoon a similar reducing division takes place, but one chromosome, the sex chromosome, divides into two dissimilar parts termed X and Y. Mature sperms each bear either an X or a Y chromosome. In the division of the ovum the sex chromatin is equally divided, and all ova bear an X chromosome. During fertilization, if conjugation of an X sperm and an X ovum occurs, the final combination will be XX, and give rise to female genetic structure; but if conjugation of a Y sperm and an X ovum occurs the final combination will be XY, and give rise to male genetic structure. There are recognizable sexual differences in the nuclei of adult cells, particularly seen as a small club shaped projection of chromatin in the nuclei of polymorphonuclear leucocytes and as a peripherally placed mass of chromatin (Barr body) in other cells in the female.

TRANSIT AND FERTILIZATION OF THE OVUM

The mechanism by which the ovum reaches the lumen of the Fallopian tube has been much discussed. The ciliated cells of the fimbriæ at the abdominal ostium of the tube set up a flow of fluid which has been shown to be capable of carrying small particles from the recto-vaginal pouch into

the tube. In addition, the injection of drops of radio-opaque fluid into the poles of the ovary at the time of laparotomy and subsequent hystero-salpingography have enabled the relative positions of the uterus, tubes and ovaries to be studied. It has been shown that the fimbriated end of the tube is brought into close contact with the ovary at the time of ovulation, although the mechanism of this is uncertain. Once the ovum has reached the cavity of the tube it is carried downwards by the ciliary action. The tubes show peristaltic movements, but the importance of these in moving the ovum down the tube is less certain. The time taken for the zygote to reach the uterine cavity after ovulation is probably about 5 days.

Fertilization of the ovum normally takes place in the Fallopian tube, although in very rare instances it may occur on the surface of the ovary as is demonstrated by the occurrence of ovarian pregnancy. The sperms reach the tube by their own active movements, passing upwards against the stream of fluid which is directed down the tube by the cilia. Spermatozoa can move at a speed of 3 mm. per minute. Numerous sperms may be found near the ovum in the tube, to which they are attracted by chemotaxis. Several may penetrate the zona pellucida, but as soon as one sperm makes its way into the ovarian cytoplasm the ovum separates from the zona and becomes impervious to further penetration.

The head of the spermatozoon represents the nucleus of the male cell, and it fuses with the nucleus of the ovum to form the segmentation nucleus, whose complement of 46 chromosomes is again complete.

EMBEDDING AND EARLY DEVELOPMENT OF THE ZYGOTE

After the formation of the segmentation nucleus the zygote starts to divide, and soon a solid clump of cells called the morula is formed. A cavity appears among the cells of the morula so that it becomes vesicular, and it is then termed the blastocyst. This stage of development is reached while the zygote is still in the Fallopian tube.

The outermost cells of the blastocyst form the trophoblast, whose function will be to bury the ovum in the uterine decidua and secure its implantation there. The trophoblast has the power of eroding and digesting the surface epithelium of the decidua, and the fertilized ovum sinks into the bed prepared for it, becoming embedded in the thickness of the decidua, lying in a cavity in the stroma between adjacent endometrial glands. The glands are distorted and pushed aside by the enlargement of the growing ovum. The aperture through which the ovum entered the decidua is sealed over with a plug of fibrin. Maternal blood-vessels are invaded and eroded by the trophoblast, and extravasation of maternal blood occurs around the ovum.
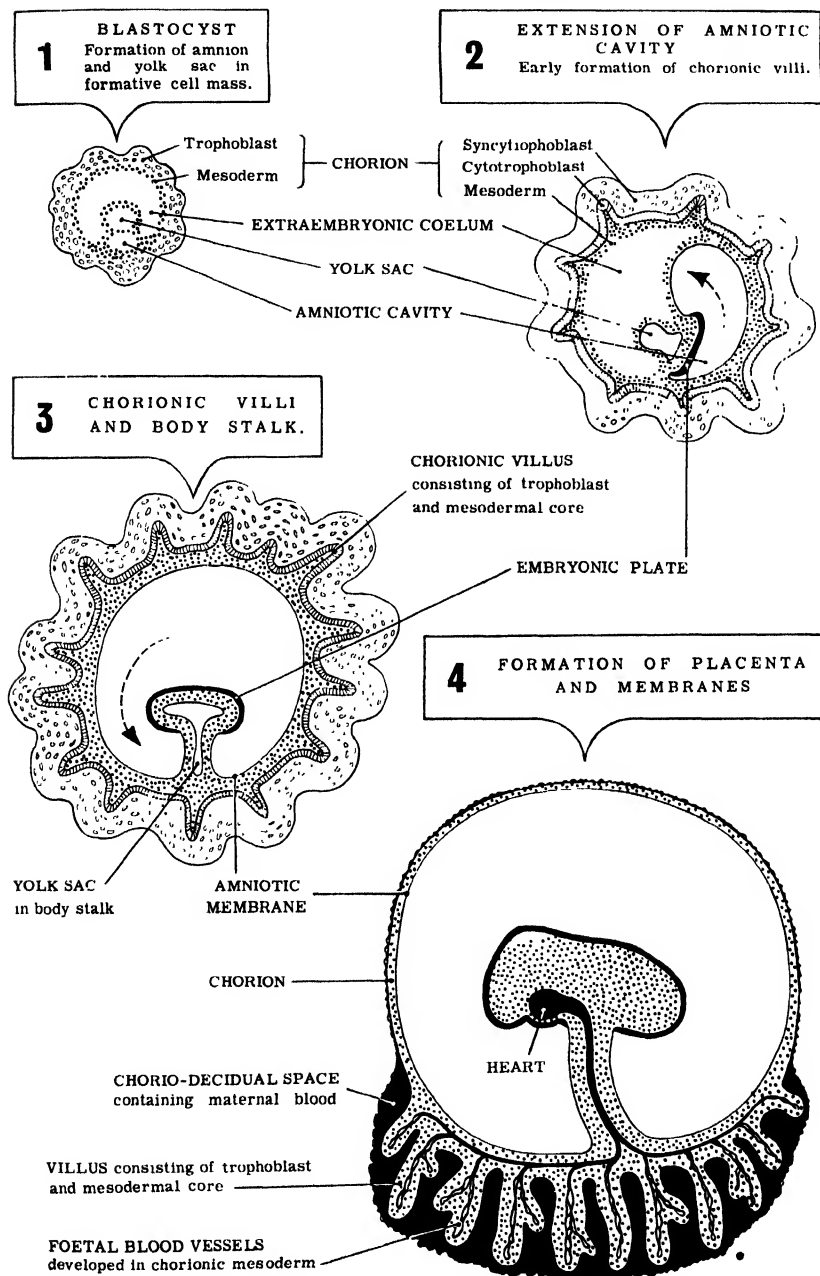
1 BLASTOCYST
Formation of amnion
and yolk sac in
formative cell mass.

2 EXTENSION OF AMNIOTIC
CAVITY
Early formation of chorionic villi.

Trophoblast
Mesoderm ⎤ CHORION ⎡ Syncytiophoblast
Cytotrophoblast
Mesoderm

EXTRAEMBRYONIC COELUM

YOLK SAC

AMNIOTIC CAVITY

3 CHORIONIC VILLI
AND BODY STALK.

CHORIONIC VILLUS
consisting of trophoblast
and mesodermal core

EMBRYONIC PLATE

4 FORMATION OF PLACENTA
AND MEMBRANES

YOLK SAC
in body stalk

AMNIOTIC
MEMBRANE

CHORION

HEART

CHORIO-DECIDUAL SPACE
containing maternal blood

VILLUS consisting of trophoblast
and mesodermal core

FOETAL BLOOD VESSELS
developed in chorionic mesoderm

FIG. 7. Diagrams to show the formation of the placenta and fœtal membranes.

The structure of the blastocyst is indicated in the diagrams. (See Fig. 7.) The formative cell mass, from which the embryo will develop, is seen projecting into the blastocyst, and two small cavities appear in the cells of

[By permission of Prof. W. J. Hamilton.

FIG. 8.   Section of human embryo of 10 to 11 days development.

1, Uterine gland. 2, Maternal blood-vessel. 3, Syncytio-trophoblast. 4, Amniotic cavity. 5, Embryonic ectoderm. 6, Embryonic endoderm. 7, Primitive yolk sac (exocœlom). 8, Extra-embryonic mesoderm. 9, Operculum. 10, Cytotrophoblast. 11, Artificial space between the cytotrophoblast and the extra-embryonic mesoderm. 12, Lacuna of trophoblast.

the formative cell mass, from which the amniotic cavity and the yolk sac develop. The diagrams indicate the progressive extension of the amniotic cavity, which comes to surround and envelop the embryo, and ultimately

the amniotic membrane covers the body stalk up to the point at which it becomes continuous with the embryonic ectoderm.

Very soon the trophoblast, while it is eroding into the maternal decidua, becomes arranged in projecting masses, at first in a labyrinthine formation, but later arranged as villi, which grow and branch. Maternal blood-vessels are opened by the cytolytic action of the trophoblast, so that maternal blood lies in the intervillous spaces, and the embryo starts to secure its nutrition from this. The trophoblast becomes differentiated into two layers. There is a thick outer layer of syncytio-trophoblast, in which the nuclei are scattered in a mass of cytoplasm that has no evident division into separate cells. The inner layer of cyto-trophoblast (Langhans' layer) is thinner, and consists of a single layer of rounded cells.

The blastocyst is lined with extra-embryonic mesoderm, and it will be seen from the diagrams (Fig. 7) that this is continuous with the mesoderm of the embryo itself. The extra-embryonic mesoderm is continuous with the central tissue of the villi, so that each villus has an outer covering of trophoblast and a central mesodermal core. Lacunæ appear in the meso-derm and gradually become joined to form a pattern of primitive blood-vessels, extending through both the body of the embryo and the extra-embryonic mesoderm. By this arrangement the placental circulation is ultimately formed; the fœtal heart not only pumps blood through the tissues of the fœtus itself, but also through the tissues of the placenta.

The combined layer of trophoblast and underlying mesoderm is termed the chorion, and the villi are the chorionic villi. Within the chorion is the amniotic membrane that bounds the amniotic cavity.

DECIDUA

The formation of the decidua of pregnancy has already been described. During pregnancy further thickening and hyperæmia occurs, with enlarge-ment and multiplication of the stromal cells, which form a mass of large closely packed polygonal cells, especially in the superficial stratum compactum. The endometrial glands run through this layer, elongated but otherwise unchanged in the superficial part of their course. Deeper down they are tortuous and distended with secretion. The decidua is thus differentiated into two layers, a superficial compact layer and a deeper spongy layer.

The ovum embeds in the stratum compactum and produces a slight projection into the uterine lumen, the most frequent site of implantation being the upper and posterior part of the uterine cavity. According to its relations to the embryo three parts of the decidua are distinguished.

Decidua basalis. This is the portion of the decidua which lies between the embryo and the muscular wall of the uterus. It bounds the deeper half

of the implantation cavity, and later on forms the site of attachment of the discrete placenta, and a number of thin-walled sinuses pass through it, bringing blood to the intervillous spaces. It also serves as a barrier against the invasion of the muscle by the syncytio-trophoblast, and under normal conditions the chorionic tissue does not penetrate through the decidua into the muscle.
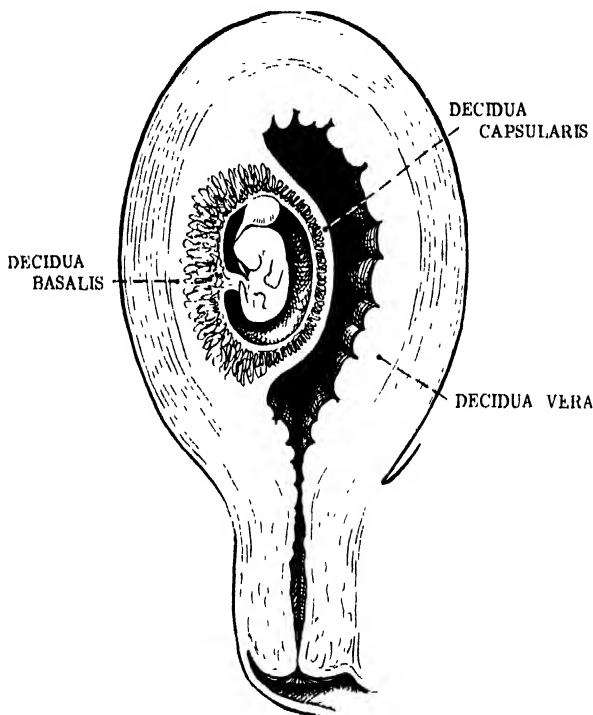

FIG. 9.   Uterus containing an embryo of about nine weeks.

Decidua capsularis. This is the portion of the decidua which intervenes between the embryo and the uterine cavity, and it bounds the superficial half of the implantation cavity. As the ovum grows it bulges out into the cavity, and by the 12th week the growing embryo fills the cavity, so that the decidua capsularis becomes fused with the decidua vera.

Decidua vera. This is the portion of the decidua that is not related to the site of implantation, and lines the rest of the cavity of the uterus.

THE PLACENTA

THE previous chapter gave a general outline of the implantation and early development of the embryo, and we may now proceed to describe the growth and anatomy of the placenta in more detail.

In the most primitive type of placenta the fœtal chorion is merely applied to the surface of the maternal decidua, so that exchange of nutrients and excretory products between maternal and fœtal blood must take place through these layers (epithelio-chorial placenta). In the human placenta the trophoblast erodes into the decidua, so that the endothelium of the maternal blood-vessels is destroyed and maternal blood is in direct contact with the chorion, without the intervention of any decidual tissue (hæmo-chorial placenta).

At first the syncytio-trophoblast forms an open reticulated mesh-work, whose lacunæ are filled with maternal blood, and in part the trophoblast replaces the maternal endothelium. The thin syncytial partitions separating the distended spaces break down so that all round the periphery of the ovum there is a slowly moving maternal circulation. This cavitation, as it proceeds, separates that part of the trophoblast which is in contact with the maternal tissues, called the junctional zone, from that which forms the immediate boundary of the blastocyst, and which, when the embryonic mesoderm appears, will constitute the chorion.

About the 13th day the trophoblast, broken up by the lacunæ, presents syncytial trabeculæ, into which there occurs an extension of cyto-tropho-blast which differentiates into cyto-trophoblastic cell columns. This is the gradual initiation of the villous stage, with the trabeculæ referred to as the *primary villi*, and the lacunar spaces lined by a thin sheet of syncytio-trophoblast and communicating freely with one another and containing maternal blood as the *intervillous space*. When the embryonic mesoderm appears, secondary cores of loose extra-embryonic mesoderm (mesenchyme) can be seen within these cyto-trophoblastic columns forming *secondary villi*. By the 15th or 16th day *tertiary or definite villi* results from the vascularization of these secondary villi by the formation of an arterio-capillary-venous system in the mesenchymal core of each villus. The columns of cyto-trophoblast pierce the trophoblastic shell at many points and come into direct contact with the decidua, thus anchoring the main villi to the maternal tissues at the junctional zone. Here can be seen, lying between the invading trophoblast and decidua, a wavy layer of fibrin—the layer of Nitabuch. The number of these primary or anchoring

villi is small, but by budding from them and from the chorion, true chorionic villi are formed, which differ from the former in that their outer ends apparently protrude free into the intervillous space. The capillaries in the terminal parts of the villi are much convoluted, with an arrangement reminiscent of that in a renal glomerulus, but adjacent villi are not joined, i.e. the villi do not form a reticulum.

Structure of a chorionic villus. This consists of a core of mesoderm, or stroma, and an epithelial covering.

The stroma at a very early stage consists of anastomosing small stellate cells enclosing clear lymph spaces, but from the middle of pregnancy there is a definite connective tissue appearance. Embedded in the stroma are
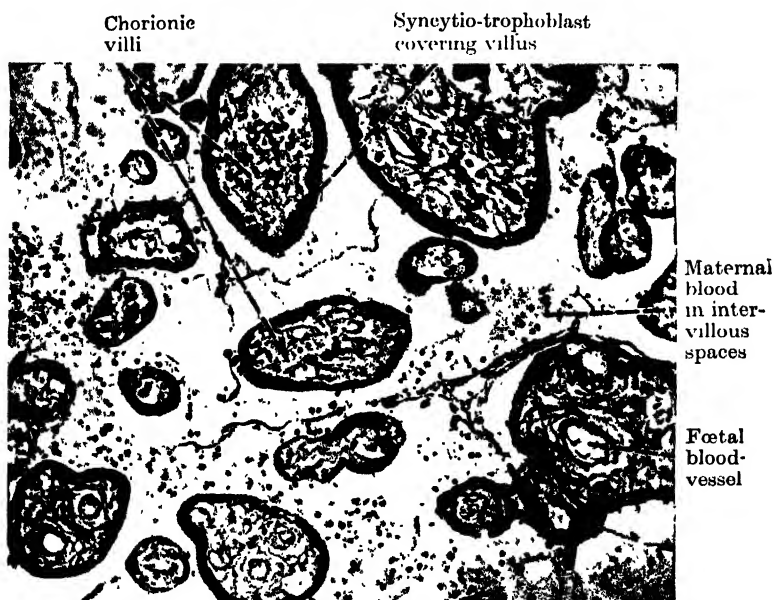

FIG. 10.   Vertical section through human placenta at term.   × 170.
(Smout and Jacoby: *Gynaecological and Obstetrical Anatomy*)

numerous blood-vessels. In the main villous stems the arteries and veins have connective tissue walls, but in the terminal villi only capillaries are present. The arteries are branches of the umbilical arteries and end in the terminal villi as capillaries from which purified blood is collected into venous radicals to pass back into the veins of the main villous stems, and thence *via* the veins of the chorionic plate to the umbilical vein of the cord.

From the time of their formation in the 3rd week until the end of the

12th week, the epithelial covering consists of a single inner layer of cyto-trophoblast (Langhans' cells) in immediate contact with the stroma, and an outer layer of a multi-nucleated mass of protoplasm (syncytio-trophoblast) in immediate contact with the blood in the intervillous space. After the 20th week the cyto-trophoblast begins to disappear until finally only a thin layer of syncytium remains. This condition persists until term.
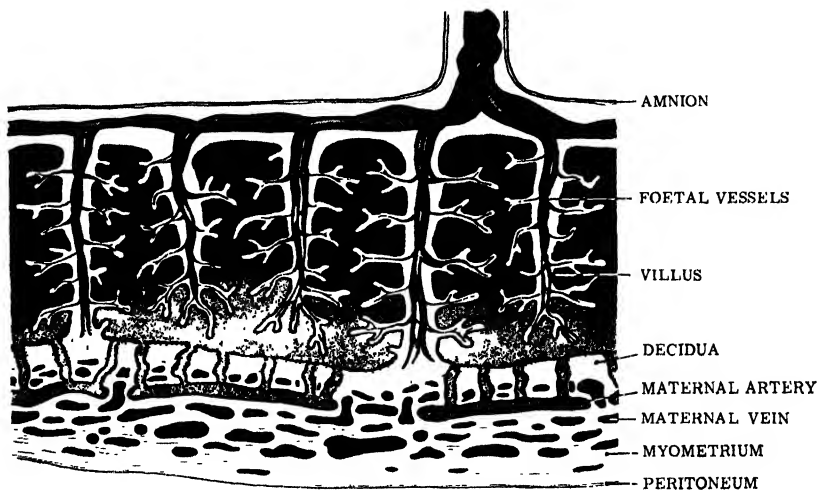

FIG. 11.   Diagram to show the structure of the placenta.

Further development of the placenta. The chorionic villi are formed in immense number, and constitute the vast bulk of the villous system which covers the placental area. Thus comes about an arrangement whereby over a great surface, thin walled vessels carrying fœtal blood are merely separated from the maternal blood by the meagre connective tissue of the villi and a thin layer of trophoblast.

At first villi are formed all over the surface of the gestation sac, so that an ovum of 4 weeks' growth appears as a translucent thin walled sac, covered by a spherical halo of soft villi like floss silk (Fig. 12). As growth proceeds, the decidua capsularis becomes thinner and between the 12th and 16th weeks, the villi on the capsular surface of the ovum rapidly degenerate, leaving this side of the chorion smooth (chorion læve). In compensation, those on the surface opposed to the decidua basalis hyper-trophy greatly (chorion frondosum) and become matted into a solid disc which is the fully developed discrete placenta. The naked eye appearance has not the least resemblance to the aureole of free villi which covers the ovum at 4 weeks, but the microscope at once reveals the identity of one with the other.

The discrete placenta is formed by the 12th week, though proportionately it then comprises a much larger part of the ovular surface than it does at term.

Increase in size of the placenta. During the 4th and 5th weeks, irregular sheets of trophoblastic tissue project from the maternal side of the intervillous maternal blood-space, so dividing this space into sinuses. How these trophoblastic septa are formed is not certain, but it is to be noted that they do not reach the fœtal side of the intervillous space. From

FIG. 12.   The chorionic villi.

(Smout and Jacoby: *Gynaecological and Obstetrical Anatomy*)

the end of the 4th week, when the villi have penetrated towards the decidua basalis, there is no further invasion.   Further growth in thickness of the placenta is now due to growth of the chorionic villi with an accompanying expansion of the intervillous sinuses. These sinuses are entirely within the fœtal tissue, and only in the pathological placenta accreta is the trophoblast found penetrating the thin basal decidua. Until the end of the 16th week, the placenta grows both in thickness and circumference. Subsequently there is no increase in thickness, but the placenta continues to increase in size circumferentially until near term. The growth is proportionate with that of the fœtus and of that part of the wall of the uterus to which the placenta is attached.

The placenta at term. The placenta at term is circular in shape. forming a spongy disc 20 cm. (8 inches) in diameter, and about 2·5 cm. (1 inch) thick near the insertion of the umbilical cord when this is centrally placed. It thins off towards its edge, which is abrupt. Its weight is about 500 g. (1¼ pounds), but there is some variation according to the size of the child.

It has a fœtal and a maternal surface. The fœtal surface is covered by smooth amnion underneath which the chorion is closely applied. The blood-vessels are visible beneath it as they radiate from the insertion of the umbilical cord. The maternal surface is rough and spongy, and presents a number of polygonal areas known as cotyledons, each being somewhat
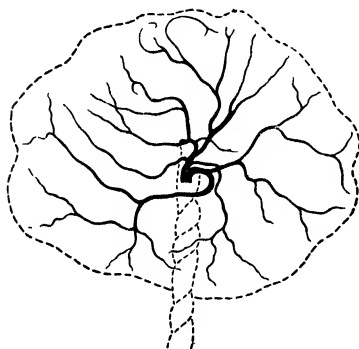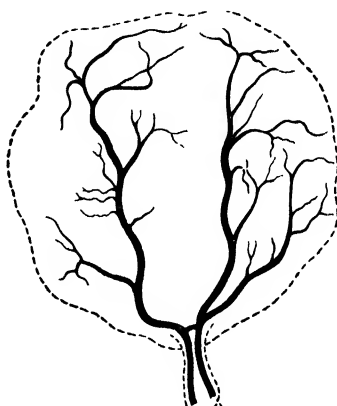

FIG. 13.   Disperse type of   FIG. 14.   Magistral type of
      placenta (Smout).   placenta (Smout).

convex, and separated from those adjoining it by a shallow groove. Each cotyledon is formed by, and corresponds to, a main villous stem and its system of branch villi. The number of cotyledons, between 15 and 20, depends on the number of end arteries into which the umbilical artery divides, and this is determined by the number of the anchoring villi. The colour is a dull red, with a thin greyish and somewhat shaggy layer on the surface which is the remnant of that part of the decidua basalis which has come away with the placenta. Numerous small greyish spots are frequently seen on the maternal surface. They are due to the deposit of calcium in degenerate areas and are the result of normal senescence. They are more numerous in placentæ at term. These deposits do not occur in the villi nor interfere with the maternal circulation in the intervillous spaces, and are of no importance.

The chorion spreads away from the edge of the placenta to form the

outer layer of the two membranes which enclose the fœtus and liquor amnii. Though the line of demarcation between the placental edge and the chorion is sharp, yet they are essentially one structure, for the placenta is a specialized part of the chorion.

The umbilical cord usually reaches the fœtal surface of the placenta about the middle of its disc, though sometimes at its edge (battledore placenta), and brings with it two umbilical arteries and one umbilical vein. The arteries having reached the placenta, distribute themselves in two

FIG. 15. Injection of capillaries in the placenta (Smout).

main ways: (a) when the arteries, dividing dichotomously, at once spread themselves over the surface (Fig. 13); and (b) when they extend almost to its margin before they break up and their calibres diminish (Fig. 14).

The area supplied by each artery differs, being sometimes equal, and sometimes unequal. Whichever method of distribution obtains, there is always a communication between the two arterial systems shortly after the arteries have reached the placenta in order to equalize the pressure in the two systems. Except for this communication, the main trunks into which the arteries divide are terminal, and each ends in a tuft of capillary vessels (Fig. 15). These tufts correspond to the cotyledons in which they are in

free communication with the venules, which make up the corresponding tributaries of the umbilical vein.

The substance of the placenta is made up almost entirely of a multitude of chorionic villi, most of which protrude in an arborescent manner into the intervillous blood-spaces. The placenta might be described as a space containing maternal blood, which is bounded on the maternal side by a decidual plate, and on the fœtal side by a chorionic plate from which the chorionic villi branch into the maternal blood. Spanner believed that the fœtal vessels ran in septa from the chorionic plate to the decidua, and then turned back again towards the chorion before giving off the fine branches to the villi, but this view is no longer accepted and the simpler plan shown in Fig. 11 is probably correct.

The intervillous space can be regarded as a lake of maternal blood which has left the maternal vessels slowly to flow round in a space bounded by fœtal trophoblast. To supply this space arteries and large sinuses perforate the decidual plate. Some observers have maintained that the blood flows to the edge of the placenta to be collected in a 'marginal sinus' before leaving the intervillous space, but this is not generally accepted, and vessels serving the arterial inflow and venous drainage appear to be scattered indiscriminately over the entire decidual plate. There are no nerves in the placenta.

FUNCTIONS OF THE PLACENTA

The placenta has the following functions:

1. It enables the fœtus to take oxygen and nutrients from the maternal blood.
2. It serves as the excretory organ of the fœtus; carbon dioxide and other waste products pass from the fœtal to the maternal blood.
3. It forms a barrier against the transfer of infection to the fœtus, although a few organisms, such as the virus of rubella and the spirochæte of syphilis are able to pass.
4. The placenta secretes chorionic gonadotrophin, œstrogen and progesterone in large amounts, and possibly other hormones, which play an essential part in the maintenance of the decidua and the growth of the uterus and breasts.

In general the trophoblast and underlying endothelium of the fœtal vessels behave as a semi-permeable membrane, allowing the free passage of water and soluble substances of relatively low molecular weight according to the laws of osmotic equilibrium, but preventing the passage of substances of high molecular weight and of particles such as red blood-corpuscles or bacteria. In a microscopical section it can be seen that the nucleated red cells in the fœtal capillaries of the villi are completely

separated from the maternal red cells in the intervillous space. Nevertheless, perhaps because of occasional breaking off of the delicate fronds of the chorionic villi, a few fœtal red cells and fragments of villi may occasionally enter the maternal circulation and can be identified in blood smears. This entry of a few red cells in cases in which the blood groups of the fœtus and mother are different explain the production of maternal antibodies against fœtal red cells, which is observed in cases of hæmolytic disease.

Substances with a molecular weight of less than 1000 are, in general, able to pass the placental barrier, and it is to be noted that most anæsthetic agents and drugs fall into this class. The concentrations of water, sodium chloride, magnesium, urea and uric acid are equal in maternal and fœtal blood. However, it has been found that a few substances are in higher concentration in fœtal than in maternal blood, including amino-acids, nucleic acid, calcium and inorganic phosphorus, and it is therefore suggested that the trophoblast has some power of selective transfer of these, most of which, it will be noted, are substances necessary for the building of fœtal tissues. Glucose is found in higher concentration in maternal than in fœtal blood, not because it does not pass the placenta freely, but probably because of its continual utilization by the fœtus. Iron passes in solution from the maternal plasma to the fœtus.

The mechanism of transfer of fats and lipoids such as cholesterol to the fœtus is uncertain. It is known that most of the fat in fœtal tissues is synthesized from carbohydrate, and it was once believed that the placenta was absolutely impermeable to lipoid substances, but recent investigations suggest that some of these substances may pass unchanged, so that it may turn out that fœtal fat has a dual origin, chiefly from synthesis from carbohydrate, but with a minor addition by direct transfer of maternal lipoids.

Although most substances of high molecular weight do not pass the placental barrier, there are unexplained exceptions, such as the transfer of antibodies from the mother to the fœtus.

As regards hormones, it is known that œstrogens, androgens and thyroxine pass the placenta, whereas probably insulin, parathyroid hormone, and posterior pituitary hormones do not. The vagina of the newborn child shows evidence of the œstrogenic action of maternal hormones *in utero*.

Placental permeability increases as pregnancy progresses, probably because the trophoblast becomes thinner as pregnancy proceeds, and also because the villi become finer and more branched. The transfer of oxygen to the fœtus is discussed below.

Placental hormones. The placenta is an organ of internal secretion, and secretes œstrogens, progesterone, chorionic gonadotrophin and also

perhaps a hormone resembling adrenocorticotrophin. During pregnancy there is a progressive increase in the blood œstrogen and the urinary œstrogen concentration which reaches a peak just before the onset of labour. The disappearance of œstrogens from the blood and urine after the birth of the placenta almost certainly indicates the placenta as the source, although the placenta may, in addition, be a storehouse for œstrogens produced elsewhere. Until the end of the 8th week the corpus luteum continues to secrete progesterone. With the gradual failure of this structure the placenta becomes responsible for the secretion of progesterone which, like that of œstrogen, reaches a peak just before labour. The excretion of progesterone in the urine in the form of pregnandiol is about 10 mg. per diem in the 8th week and reaches a level of about 80 mg. by the end of pregnancy. As in the case of œstrogen, progesterone may be formed in the adrenal cortex and stored in the placenta. Chorionic gonadotrophin appears in the urine as early as 8 days after the first missed period. It reaches its peak concentration at 50 to 60 days, then falls rapidly to a low level at which it remains steady, and finally disappears at a very variable rate a few days before the onset of labour. Chorionic gonadotrophin usually disappears from the urine if the fœtus dies and may persist after labour if placental tissue is retained. The presence of this hormone in the urine forms the basis of the various tests for pregnancy, being produced in the cyto-trophoblast. Placental steroids are produced in the syncytium.

THE CHORIONIC MEMBRANE

After the discrete placenta is formed, the rest of the chorion atrophies and persists only as a thin, friable membrane intervening between the amnion and the decidua. On its outer surface, vestiges of decidual cells and of the trophoblastic layer with which it was formerly covered can be distinguished microscopically, but the bulk of it is a fragile connective tissue, which is loosely attached to the amnion.

Sometimes vessels from the umbilical cord can be seen running across it, and occasionally the cord itself is attached to the chorion outside the placental margin, so that the umbilical arteries and veins run across it to reach the placenta (velamentous insertion). Very rarely the whole surface remains placental up to an advanced stage of pregnancy, a maintenance of the early condition (placenta diffusa, p. 23).

THE AMNION

The first appearance of the amnion is a hollow space in the embryonic ectoderm. It is lined by cubical cells, which quickly become more columnar at the part which eventually forms the embryonic plate and the embryo. At first more or less spherical, the amniotic cavity soon becomes flattened

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down upon the embryo and closely applied to it. As the head and tail appear and the body-walls fold round to enclose the embryonic cœlom, the amnion attached at their margins is carried round also, so that the embryo is, as it were, pushed up and projects into the amniotic cavity. When the body cavity of the embryo is quite closed up, the amnion is attached all round the place at which the ventral stalk emerges. (See Fig. 7.)

At this period the embryo is relatively very small, and has the amnion closely applied to it, while the cavity of the blastocyst is relatively very large. Now a great change begins to occur. The amniotic cavity enlarges out of proportion to the embryo, and becomes distended with fluid, and the embryo is gradually carried more and more into the amniotic cavity by elongation of the ventral stalk, which becomes the umbilical cord.

The enlargement of the amniotic cavity which brings about the complete investment of the umbilical cord likewise brings the amnion into close contact with the fœtal surface of the placenta. This surface is, therefore, completely covered by the amnion. The amnion is attached to the placenta and chorion is a loose manner, and can be separated up to the insertion of the cord.

The amnion is lined by a single layer of cubical or flattened epithelial cells which is attached to a layer of connective tissue. The epithelium contains granules, fat droplets and vacuoles. The connective tissue upon the outer side of the amniotic membrane is closely applied to the similar connective tissue upon the inner side of the chorion; the two merely stick together, but are not organically united. They can easily be separated from one another at all periods of pregnancy. That portion of the amnion which covers the umbilical cord, however, is very closely incorporated with the connective tissue of the cord and cannot be stripped off.

Amniotic fluid. *The amniotic fluid is usually slightly turbid from the admixture of solid particles derived from the fœtal skin and the amniotic epithelium. It may also be stained a greenish colour if any meconium has been passed into it.*

The composition of the fluid at term is as follows: It has a specific gravity of about 1010. It contains inorganic salts, chiefly alkaline chlorides, phosphates and sulphates, and albumin. Urea is present from the 5th week onwards in increasing amounts up to full time. The solid matter is composed of lanugo, hairs, epithelial cells and sebaceous material from the fœtal skin, and cast-off amniotic epithelial cells.

The amount of amniotic fluid at term averages 600 ml. (20 ounces), but the volume varies widely, perhaps from 300 to 1500 ml. in normal cases. The amount of the fluid relative to the size of the fœtus is much greater in the early months of pregnancy, when the fœtus floats freely in it.

The origin of the liquor amnii is still uncertain. Although the fœtus passes small quantities of urine into the amniotic fluid in late pregnancy the contribution from this source is very small. Nearly all the fluid must somehow pass into the cavity through the amniotic membrane, and the question whether the fluid is a secretion or a simple transudate is still unsettled. Vacuoles have been observed in the cells of the amniotic epithelium, but it is by no means certain that these indicate secretory activity.

Recent investigations using radio-active isotopes have given surprising results. In each hour about 500 ml. of water, 13 mEq. of sodium and 0·6 mEq. of potassium are exchanged between the amniotic fluid and the maternal plasma. This means that about half the fluid in the amnion is exchanged every hour. The question whether this exchange takes place directly between maternal plasma and amniotic fluid, or indirectly through the fœtal plasma, appears to have been settled by recent investigations which showed that there was a constant exchange of about 3000 ml. per hour between maternal and fœtal plasma, and an exchange of about 400 ml. per hour between fœtal plasma and amniotic fluid, but no direct exchange between maternal plasma and the fluid.

The presence of lanugo, hairs and epithelial scales in meconium shows that the fluid is certainly swallowed by the fœtus, and some of it passes from the gut, or possibly the lungs, into the fœtal plasma.

Uses of the liquor amnii. The liquor amnii provides a protective medium for the fœtus, guarding it against shocks and jars, equalizing the pressure exerted by uterine contractions, and allowing it, at least in the early months, plenty of room for free movement. There can be no doubt that some of it is swallowed, but it can hardly be regarded as a source of nutriment for the fœtus, because the content of albumin and salts is so small, although it will supply some water to the fœtus. During labour the liquor amnii contained in the bag of forewaters forms a fluid wedge which, under the influence of the uterine contractions, operates upon the internal os uteri and canal of the cervix. Labour will progress normally, however, without this mechanism when the membranes have been ruptured. When the membranes rupture at the end of the first stage of labour, liquor amnii flushes the birth canal from above downwards with a fluid which is aseptic and bactericidal.

THE UMBILICAL CORD

The umbilical cord, or funis, forms the connexion between the fœtus and the placenta. It is derived from the ventral stalk and receives a close covering of amniotic epithelium. The constituents of the umbilical cord are as follows:

Bipartite and tripartite placenta. Instead of a single disc the placenta may consist of two or three lobes, usually partly fused, but sometimes completely separate except for their vascular attachments. Such abnormalities are of no significance.

Placenta succenturiata. This anomaly is not uncommon. One or more accessory lobules of placental substance are found on the chorion at a distance from the edge of the main placenta. They are united to the placenta by vascular connexions, both arterial and venous. The placenta succenturiata is of clinical importance because it is liable to be retained in the
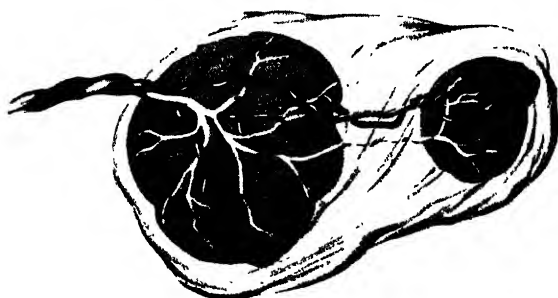
FIG. 16.   Placenta succenturiata, showing vessels running in the chorion from the margin of the main placenta to the accessory portion.

uterus after the placenta proper has been expelled. Postpartum hæmorrhage may follow, because the retained lobe interferes with the retraction of the uterus, and if organisms invade the retained tissue it may be a source of infection of the uterine wall.

This abnormality should be discovered when the membranes and placenta are inspected after delivery, when a round defect will be seen in the membranes, and a leash of vessels will be seen running from the edge of the placenta to end abruptly where they have been torn across at the edge of the defect. In such a case the uterine cavity should immediately be explored, and the succenturiate lobe removed.

Placenta membranacea. Sometimes the placenta is oval or ring shaped with a central defect which is occupied only by the membranes. This is of no significance.

Placenta circumvallata. This is due to a late outward proliferation of chorionic villi because the original area of the chorion frondosum was unduly small. As a result the chorionic villi later proliferate outwards into the decidua, beneath the ring of attachment of the amnion and chorion. A white ring is seen on the fœtal aspect of the placenta, and this bounds a central depression, from which the fœtal vessels radiate and disappear under the white ring. This abnormality does not usually interfere with placental function but it is frequently a cause of antepartum or intrapartum bleeding.

Variations in the attachment of the umbilical cord. The umbilical cord is usually attached to the centre of the placenta, but sometimes it is eccentric, or attached to the edge of the placenta (*battledore placenta*). This is of no importance.

In rare cases the cord is attached to the membranes at some distance from the edge of the placenta, and at this point the vessels may divide into branches, which may run on the membranes for some distance before reaching the edge of the placenta (*placenta velamentosa*). This may be dangerous to the fœtus if the vessels happen to pass across that part of the chorion that lies below the presenting part (*vasa prævia*), as a branch may be torn when the membranes rupture.
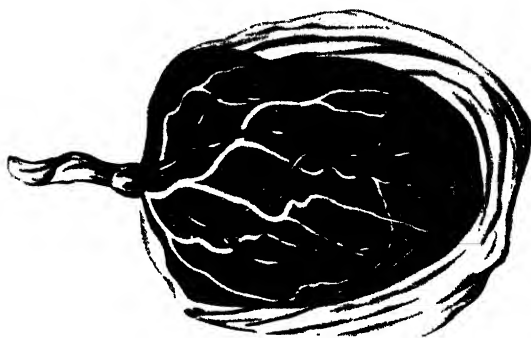
FIG. 17. Battledore placenta.

Placenta accreta or increta. In the third stage of labour the placenta normally separates through a plane which runs through the thickness of the maternal decidua. The superficial part of the decidua comes away with the placenta, and the deeper part remains on the uterine wall. The layer of separation corresponds to the stratum spongiosum of the decidua. Normally the chorionic villi only penetrate into what corresponds to the stratum compactum of the decidua, and the loose stratum spongiosum therefore underlies the whole placenta.

If the chorionic villi invade more deeply the placenta is abnormally adherent and the condition is termed placenta accreta or increta.

In the former condition there is a solid fusion between the placenta and the decidual tissues, the spongy layer is absent and there is no plane of cleavage; in the latter the chorionic villi actually penetrate the uterine muscle so that the placenta and the uterine wall become one solid continuous mass. Sometimes the area of adhesion is limited to part of the placental site, but in other cases the entire placenta is firmly attached. Morbid adhesion of the whole placenta occurs about once in 20,000 deliveries.

Clinically there is delay in the third stage, when the condition must be diagnosed from a separated placenta retained above a contraction ring and from simple retention due to inefficient retraction of the uterus. In morbid adhesion of the whole placenta there is no bleeding, as no part of the placenta separates. Morbid adhesion of the placenta can only be recognized by failing to find a plane of cleavage when an attempt is made to remove it manually. If the adhesion is only partial it is usually possible to remove the placenta, but there is some risk of leaving part of it behind.

In cases of complete placenta accreta it may be possible to remove the placenta piecemeal; but this is a difficult and dangerous procedure. Unless hæmorrhage has been caused by attempts to remove the placenta, or the uterus has been damaged, when hysterectomy is inevitable, it may be justifiable to leave the placenta *in situ*, and await its separation by necrosis. Antibiotics should be given during this time.

DISEASES OF THE PLACENTA

Tuberculosis of the placenta. Tuberculosis in the fœtal portion of the placenta is very rare. Local lesions have, however, been found in the decidua and in the chorion when the mother has generalized tuberculosis.

Syphilis of the placenta. The syphilitic placenta is, as a rule, heavier than the normal placenta; but increase in weight is not evidence of syphilis, as it may occur in other conditions. A macroscopic examination will not provide evidence of the disease, and it is only in microscopic sections that any evidence suggestive of syphilis will be found. In the syphilitic placenta the chorionic villi are larger, more numerous and crowded together, and often the vessels have disappeared. An obliterative endarteritis of the fœtal vessels may occur and thickening is not infrequent in the coats of the vessels of the chorionic villi if they persist. The presence of the *Spirochæta pallida* may be demonstrated, but not always easily.

Placenta in erythroblastosis fœtalis. In mild degrees of this condition no abnormality may be evident, though the placenta may be stained yellow with bile pigment. In hydrops fœtalis the œdematous placenta is large, pale and friable and often as heavy as the fœtus itself. There is abnormal persistence of the Langhans cells of the chorionic villi (cyto-trophoblast). The reason for this is not fully understood.

Degenerative changes in the placenta. The placenta has a limited life span; it is in active growth for about 30 weeks, and after that time degenerative changes are commonly found in it. In the past any degenerative change in the placenta was termed a placental 'infarct', but this term should

be given up, as the abnormalities included under it bear no resemblance to the ordinary infarct of general pathology, which is due to occlusion of the artery supplying part of an organ. The chorionic villus is nourished by maternal blood flowing slowly in the intervillous space, which bathes its entire surface, and obstruction of the central fœtal arteriole will not cause its death.

Fibrinoid degeneration. In nearly every mature placenta white fibrinoid areas may be found near the periphery, or under the chorionic plate, or in the septa between cotyledons ('white infarcts'). Such areas are due to fibrinoid degeneration of trophoblast. Not all the trophoblast becomes effectively vascularized and these subchorionic and vascular 'infarcts' are merely areas in which surplus trophoblast, which has never been effectively organized into villi, has degenerated. Such lesions do not interfere with fœtal nutrition.

Intervillous thrombosis. Another more important type of lesion is due to coagulation of maternal blood in the intervillous space. A 'red infarct' is formed, consisting of coagulum enclosing villi whose blood supply has been cut off. In time such a lesion becomes organized, and forms a 'white infarct' consisting of a mass of fibrin surrounding the degenerating villi. The cause of intervillous thrombosis is not always evident, but it may be due to damage to or senescence of the trophoblast, so that the surface is broken, and the blood clots. The slow blood-flow in the intervillous space is not enough to remove small clots, so that the thrombosis may extend. Small lesions are unimportant, and can probably be found in every placenta, but if large areas of the placenta are involved the fœtal oxygenation and nutrition are disturbed.

Calcification of the placenta. Calcification is often observed on the maternal surface of the mature placenta in the form of numerous scattered gritty areas. Other small deposits may occur in areas of degeneration in the substance of the placenta. The common deposits on the maternal surface are in the decidua, and do not interfere with the maternal blood flow to the intervillous space. Such lesions are of no importance, but are sometimes a useful means of determining the position of the placenta in an X-ray photograph.

Cysts of the placenta. Small cysts may occur in the chorionic plate of the placenta, due to liquefaction in an area of fibrinoid degeneration. They are of no importance. Less frequently other small cysts may occur in areas of degeneration in the substance of the placenta.

Tumours. Solid tumours of the placenta are rare, and consist of masses of chorionic villi with hypertrophy of the blood-vessels. In some cases the tumour is connected with the chorion by a pedicle containing an artery and vein. These vascular tumours are termed chorio-angiomata. As a

general rule the remainder of the placenta is unaffected, but they may be associated with hydramnios, presumably due to exudation of fluid from the surface of the tumour. Very rarely secondary deposits from a primary carcinoma or melanoma in the mother occur.

ANOMALIES OF THE UMBILICAL CORD

Length. The usual length of the umbilical cord is about the same as that of the fœtus, viz. 50 cm. (20 inches), but considerable variations occur. Excessive length predisposes to descent and to the formation of coils and knots. The cord may be actually short or relatively short by being twisted round some part of the fœtus. This may cause intrauterine death of the fœtus in the very rare cases in which the cord is pulled tight. In labour delay during the second stage, rupture of the cord, premature separation of the placenta, or inversion of the uterus may occur. The treatment is to release the cord if wound round the neck after the head is born or, if necessary to clamp and divide the cord and hasten the birth of the child.

Knots may be formed as the result of fœtal movements, the child passing through a loop which later forms a knot. Knots are rarely tight enough to obstruct the circulation, but occasionally they may lead to intra-uterine death of the fœtus. Local protuberances of Wharton's jelly may give an appearance of knotting and have been described as false knots. They are of no practical importance.

Abnormal insertions of the cord. The cord may be attached at the margin of the placenta, giving rise to the battledore placenta; it is without clinical significance.

Occasionally the cord is attached to the membranes, and the component vessels break up and branch before the placenta is reached. This anomaly is known as velamentous insertion. (See p. 35.)

Single umbilical artery. This is an uncommon finding but it may be associated with other abnormalities of the fœtus.

THE FŒTUS

THREE periods may be distinguished in the development of the fœtus. *Ovular*—during the first 2 weeks; *embryonic*—during the 3rd to 5th weeks, when a definite form is assumed; *fœtal*—after the 6th week.

It is difficult to assess the age of the ova in early abortions, but generally the ovum at 4 weeks is about 2 cm. in diameter and at 6 to 8 weeks about 5 cm. The length of the fœtus rather than its weight is probably a more reliable index of its age.

In describing the length of a fœtus, the measurements in the earlier weeks are commonly taken from the vertex to the coccyx, while from the end of the 20th week onwards the measurement is taken from the vertex to the heels.

At 12 weeks the measurement from vertex to coccyx is 7 cm. or $2\frac{4}{5}$ inches.

At 16 weeks it is 12·5 cm. or 5 inches.

At 20 weeks the total length from vertex to heel is 25 cm. or 10 inches.

At 24 weeks it is 30 cm. or 12 inches.

At 28 weeks it is 35 cm. or 14 inches.

At 32 weeks it is 40 cm. or 16 inches.

At 36 weeks it is 45 cm. or 18 inches.

At 40 weeks it is 50 cm. or 20 inches.

After the 20th week the fœtus increases roughly 5 cm. or 2 inches each 4 weeks, and its length in inches is half the number of weeks of the duration of the pregnancy.

Other characteristics of the growing ovum from month to month are of value in determining the stage of development.

At 8 *weeks* the fœtus has taken on a distinctly human appearance. The 4-cm. fœtus now lies in a much-enlarged amniotic cavity, the amnion being in contact with the chorion, and the extra-embryonic cœlom is obliterated. The ventral stalk and yolk-sac stalk have united to form the umbilical cord invested by the amnion, and the primitive small intestine is contained in the dilated proximal extremity of the cord. The chief human characteristics lie in the completion of the facial form, by the formation of the nose and its separation from the mouth. At this time also the ears are completely formed externally, and the eyelids have appeared around the eyeball. The limbs are enlarging, and show their jointed appearance, and the fingers and toes are formed. The flexion of the trunk is considerably diminished and the head is lifted up, so that the vertex now forms the upper end of the embryo rather than the back of the neck.

At 12 *weeks* the placenta has taken on its complete discoid form. The amnion entirely fills the chorionic sac; the umbilical cord, still short and thick, shows a spiral twist. The proximal portion of the umbilical cord has contracted, and the primitive small intestine is completely withdrawn into the body cavity. Nails have appeared on the fingers and toes, and the two sexes are differentiated so far as the external organs are concerned. The length of the embryo is 7 cm., and its weight is about 120 g. (4 ounces).

6 weeks

14 weeks

20 weeks

36 weeks
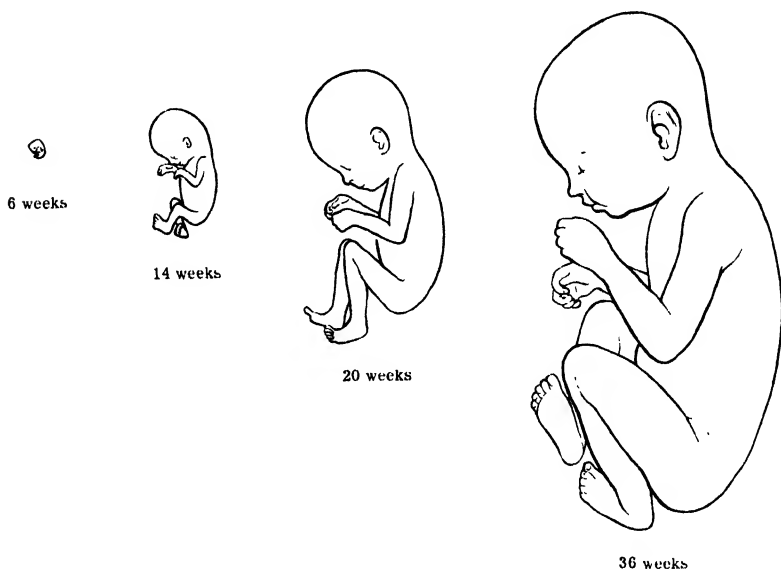
FIG. 18.

At 28 *weeks* the fœtus weighs about 1400 g. (3 pounds). The subcutaneous fat is becoming more developed, so that the skin wrinkles begin to disappear. The testicles appear in the inguinal canals. The eyelids open. At this period the fœtus is said to be viable, and the law assumes that it can survive after birth; but the number of infants which survive such premature birth is very small.

After this stage the weight of the fœtus increases with comparative rapidity, but the extent to which it does so, and the exact weight at any particular time are unknown. Much depends upon the weight it would attain if it survived *in utero* until term. Thus a 6 pounds child at term would probably have weighed 5 pounds at the 36th, and about 4 pounds at the 32nd week. A child, however, which at term weighs 12 pounds, probably weighed 10 at the 36th week. The fœtus becomes completely covered with vernix caseosa, a greasy substance, composed of the secretion of sebaceous glands mixed with dead epidermal cells. The scalp-hair

increases in length. Short colourless hairs, known as lanugo, which have previously appeared on the body and head, tend to disappear. The red colour of the skin changes to that of flesh colour owing to the formation of fat. Just before the 36th week one testicle has usually descended into the scrotum. The nails reach the ends of the fingers but not of the toes. Most infants prematurely born at or later than the 36th week will survive.

At 40 *weeks* the fœtus measures on an average 50 cm. (20 inches), and weighs as a rule between 2·7 to 3·6 kg. (6 to 8 pounds). The signs that the fœtus has reached full time are not always clear, but the measurement and weight must be regarded as very important. In addition, the nails usually project beyond the finger-ends, and have reached the ends of the toes. The skin is not red as in a premature infant, but pink. The lanugo has almost disappeared except over the shoulders. The whole of the intestine contains meconium. The umbilicus is practically at the centre of the body. Both testicles have descended into the scrotum. As a rule, only one epiphysis has commenced to ossify, that in the lower end of the femur, but the centres of ossification of the upper epiphysis of the tibia and humerus may have appeared.

The weight of the full-time child is variable. Children weighing 4·5 kg. (10 pounds) are not uncommon, but children heavier than this are decidedly rare. If a really full-time child weighs under 5 pounds it is probably very badly nourished and feeble, and on this account has a poor chance of survival. It is different with twins; both may weigh under 2·25 kg. (5 pounds), and yet, being full-time and well nourished, are likely to survive. The heaviest children are born when the mother's age is between 25 and 35 years. The weight of the child tends to increase in successive pregnancies, provided the mother's age is below 35. Very young mothers commonly have small babies. Males are heavier than females on an average. There is no legal definition of what constitutes a full-time child, but a birth weight of 2·5 kg. (5½ pounds) is accepted as an international standard for the dividing line between maturity and prematurity.

Fœtal circulation

The umbilical vein carries oxygenated blood from the placenta to the fœtus. It enters the body at the umbilicus and divides into two branches, one of which joins with the portal vein to supply the liver; the other, which is named the ductus venosus, passes directly into the inferior vena cava. The inferior vena cava also receives the blood from the liver, and that from the lower limbs and body-wall below the diaphragm. As the limbs and body-wall require but little blood, the amount from them, although venous, is not large enough to vitiate the pure blood from the ductus venosus to any great extent. This stream of oxygenated blood reaches the heart by the inferior vena cava. In the heart it is split into two

by the crista dividens, which is the posterior edge of the interauricular septum; (a) part of the blood is directed into the left atrium through the foramen ovale, and (b) the rest of the blood passes through the tricuspid valve into the right ventricle.

At the same time venous blood is returning from the head and arms by the superior vena cava, and this blood is directed by the Eustachian valve through the tricuspid valve, where it joins the stream (b) just mentioned.

Thus the left atrium receives oxygenated blood through the foramen ovale, which is joined by the relatively small flow of venous blood in the pulmonary veins, and this blood is passed on through the mitral valve to the left ventricle.

The right ventricle receives a mixture of oxygenated blood from the inferior vena cava and venous blood from the superior vena cava.

As both ventricles contact their contents pass up the aorta and pulmonary artery, but as the lungs are not expanded the ductus arteriosus allows some of the blood in the pulmonary artery to enter the aorta instead of passing through the lungs. It will be seen that the blood in the carotid arteries, supplying the developing brain, is better oxygenated than the blood going to the rest of the body, with the exception of the liver.

The greater part of the blood descending in the aorta leaves the body by the hypogastric (umbilical) arteries to be fully oxygenated again in the placenta.

Changes in the fœtal circulation at birth. The first important change is brought about by the respiratory efforts of the child directly after birth. The inflation of the lungs immediately determines the necessity for a large supply of blood to them through the pulmonary arteries. This diverts the blood-current from the ductus arteriosus, which rapidly loses its lumen and becomes impervious. Experiments on the fœtus of the sheep show that closure of the ductus arteriosus occurs in two stages, a physiological one that takes place within a few minutes of respiration commencing and an anatomical occlusion that requires a considerable time for its completion.

The blood returning from the lungs is now oxygenated instead of venous, and entering the left auricle it passes into the left ventricle, and is then distributed all over the body by the aorta and its branches. The sudden cessation of the placental circulation deprives the umbilical vein and ductus venosus of their blood-current, and consequently within an hour they collapse and empty, and subsequently gradually atrophy, becoming converted into fibrous cords. The umbilical (hypogastric) arteries, being cut off from the placenta at the umbilicus, cease to carry any blood and close, but they can be still recognized in the adult as the obliterated hypogastric arteries.

The contraction in the two umbilical arteries in the cord occurs within
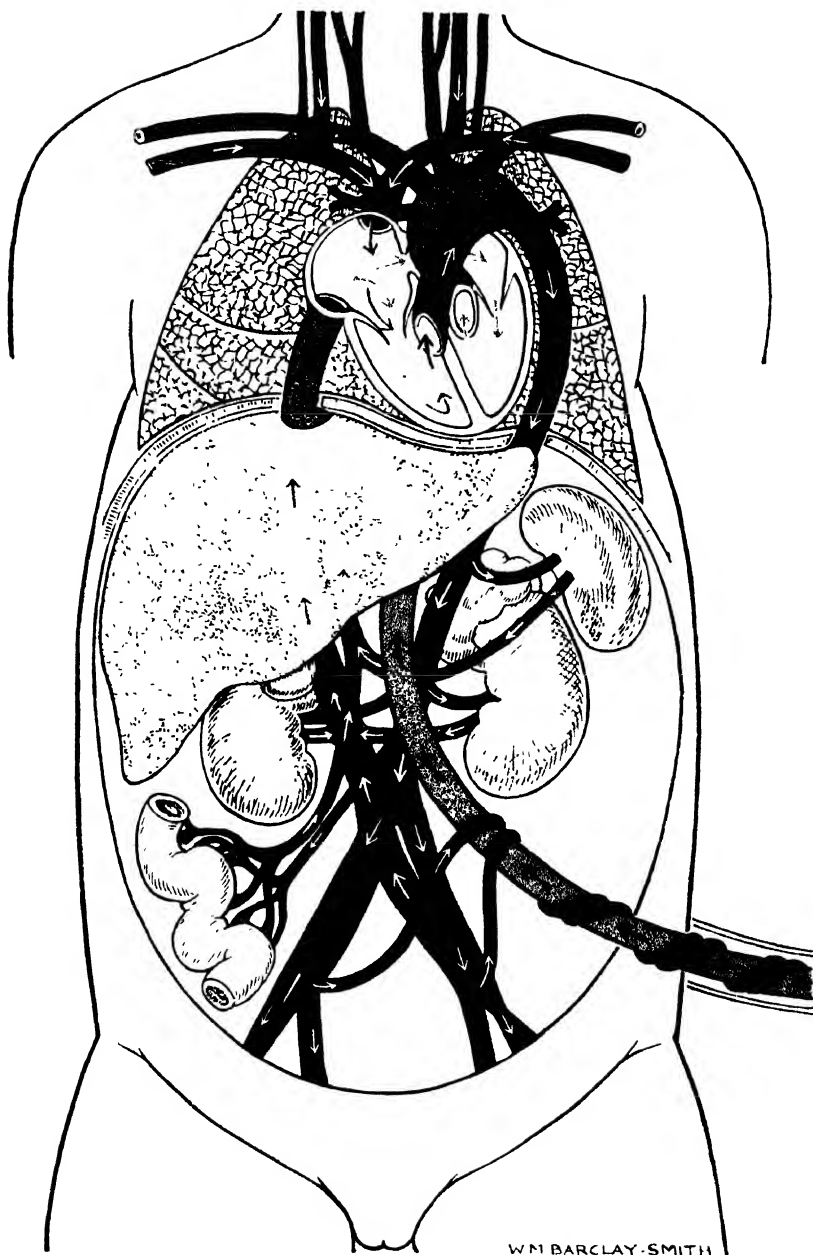
The fœtal circulation.

a few moments of the first breath and they soon cease to pulsate and so prevent any further blood leaving the child. The umbilical vein remains open for a slightly longer period, thus allowing a large quantity of placental blood to be returned to the child. It has been shown that 50 ml. of blood return to the child within a minute after birth if the cord is not tied.

The alteration in the course of the blood-stream through the heart from auricle to ventricle on each side, instead of from the right auricle to the left auricle via the foramen ovale, throws the latter aperture out of function. The foramen ovale ceases to give free passage to blood immediately after birth, but the anatomical completion of the inter-auricular septum is not effected for some months. The hypogastric arteries are usually occluded by the second day but occasionally the lower portion may remain patent.

Oxygen supply to the fœtus

As the fœtus grows it requires ever increasing amounts of oxygen. The placenta becomes more permeable as pregnancy proceeds, but in addition the fœtal blood has the advantage of being able to take up more oxygen per unit volume than the maternal blood. This is possible because the fœtal blood at term contains more hæmoglobin per millilitre and also because the fœtus has a hæmoglobin of slightly different chemical constitution.

The fœtal red cell count rises progressively from 1·5 million per cu. mm. at 10 weeks to 5·5 million at term. The cells are macrocytic, and the hæmoglobin content at term is about 18 g. per 100 ml. (130 per cent Haldane). The maternal blood at term often contains 12 g. per 100 ml. (85 per cent).

The fœtal hæmoglobin is mostly formed in the liver and spleen rather than in the bone marrow, and contains a different globin; it has the property of being able to combine with more oxygen than adult hæmoglobin, especially at low oxygen tensions.

The effect of these differences between maternal and fœtal blood is that 100 ml. of maternal blood can carry 16 ml. of oxygen if it is fully saturated, but the same volume of fœtal blood can carry 21 ml. In other words, the fœtal blood can easily take up oxygen from the maternal blood. In the outcome, as maternal arterial blood is nearly fully saturated it carries about 15·7 ml. of oxygen per 100 ml., and as fœtal arterial blood is only about 50 to 60 per cent saturated it carries between 11 and 13 ml. of oxygen per 100 ml.

Nutrition of the fœtus

Although it is of course completely dependent on the maternal blood and the placenta for its requirements, the fœtus is a separate physiological entity, and it will take what it needs from the mother, even at the cost of

reducing her reserves of some substances, for example calcium and iron. The details of fœtal metabolism need not concern us here, except to point out that for nearly every substance that the fœtus requires the rate of uptake rises progressively, and is greatest in the late weeks of pregnancy, as the following table shows:

CONSTITUTION OF THE FŒTUS (g.)

Weeks	Weight	Nitrogen	Phos-phorus	Calcium	Mag-nesium	Chlorine	Sodium	Potass-ium
16	100	0·9	0·1	0·2	0·04	0·2	0·2	0·1
24	600	6·8	1·6	3·1	0·2	1·4	1·2	0·8
32	1700	23·4	5·9	8·5	0·3	3·0	2·8	2·3
40	3400	55·9	12·9	22·7	0·5	5·1	5·0	4·7

CHANGES IN MATERNAL ANATOMY AND PHYSIOLOGY DURING PREGNANCY

ALTHOUGH the anatomical and physiological changes that occur during pregnancy chiefly involve the genital tract and the breasts, many other inter-related changes occur in other systems of the body. All these changes are initiated by hormones produced by the fœtal chorionic tissue. The most important alterations in maternal physiology during pregnancy may be summarized thus:

1. *Hormonal changes.* Placental, and perhaps other, hormones maintain the decidua, initiate the growth of the myometrium, increase the vascularity of the whole genital tract, and cause proliferation of the glandular tissue of the breasts. These hormones have other secondary effects, including the retention of water in the body, relaxation of smooth muscle especially in the urinary tract, and possibly relaxation of pelvic ligaments.

2. *Changes due to the uterine enlargement.* The increased blood-flow through the uterus, causes great changes in the maternal circulation, and the enlarged uterus alters the general posture and affects the mechanism of respiration.

3. *Metabolic changes.* The fœtal requirements of oxygen and food substances, and the growth of the uterus and preparation for lactation, affect the mother's metabolism and dietary needs. We may now consider some of these changes in detail.

Endocrine system. (*a*) *Fœtal hormones.* We have already described how the fœtal trophoblast produces large amounts of chorionic gonadotrophin, especially in the first trimester of pregnancy (see p. 28). During pregnancy large quantities of this hormone are present in the blood and urine, and it is believed that high concentrations of this substance prolong the life span of the corpus luteum, which in turn continues to produce œstrogen and progesterone and so to maintain the uterine decidua until the output of œstrogen and progesterone from the placenta rises.

Large amounts of œstrogens and progesterone are found in the blood and urine during pregnancy, at first secreted by the corpus luteum, but chiefly from the placenta after the 12th week. The product derived from progesterone which is excreted in the urine is pregnandiol. Even if the corpus luteum is removed in early pregnancy the hormone levels continue to rise,

and it has been shown that the placenta contains large quantities of these hormones. Œstrogen and progesterone maintain the decidua of pregnancy, cause the growth and hyperæmia of the uterus and lower genital tract, and the hyperæmia and development of the breasts.

Estimates of the amount of œstrogens excreted in the maternal urine (as œstriol) during pregnancy may be used as an indication of placental activity. An alternative method of assessment of placental function is to examine vaginal smears. In normal pregnancy the percentage of cornified cells (cornification index) is less than 10, and the cells are folded (navicular) in form and clumped together.

(b) *Other maternal endocrine changes.* During pregnancy the anterior lobe of the pituitary gland undergoes hypertrophy, with increase of both acidophil and basophil cells. No anatomical changes are evident in the posterior lobe of the pituitary gland.

The thyroid gland is slightly enlarged during pregnancy, and the basal metabolic rate is increased.

There is an increased concentration of adrenal gluco-corticoid hormones in both the blood and the urine, and there is some evidence that the placenta secretes an adreno-corticotrophic substance. During pregnancy the number of eosinophil cells in the blood falls. The observation that rheumatoid arthritis often undergoes a remission during pregnancy may be explained by the increased secretion of glucocorticoids. There is also some increase in the excretion of mineralocorticoids (aldosterone).

Uterus. During pregnancy the uterus is adapted to contain the growing fœtus and placenta, and it also undergoes changes in preparation for its task of expelling the fœtus during labour. The changes include development of the decidua (see p. 19), hypertrophy of the muscle coat, increased vascularity, formation of the lower segment, and softening of the cervix.

At term the uterus is 30 to 35 cm. (12 to 14 inches) long, and about 23 cm. (9 inches) in diameter. It weighs 1 kg. (2 pounds), in contrast to the non-pregnant uterus which weighs 65 g. (2 ounces). The uterus soon becomes too large to remain in the pelvic cavity; the fundus of the uterus reaches the level of the top of the symphysis pubis at about the 10th week, and thereafter it lies against the anterior abdominal wall, displacing the other viscera to the side or back of the abdominal cavity. The fundus reaches the level of the umbilicus at about the 22nd week, and the xiphisternum at about the 36th week. The fundus may then sink down somewhat, especially in cases in which the fœtal head descends deeply into the pelvic during the last 4 weeks. After the 20th week the average upward growth of the uterus is 3·75 cm. (1½ inches) per month.

The pregnant uterus is usually rotated slightly on its long axis, so that the anterior surface faces a little to the right, and the fundus may also be

inclined to one or other side, most often the right. At term the main axis of the cavity of the uterus is at a right angle to the plane of the pelvic brim. The enlargement of the uterus is greatest at the fundus, so that the points of entry of the Fallopian tubes appear to lie well below the top of the uterus.

The enormous growth of the myometrium during pregnancy is due to two factors—hormonal stimulation and distension. During early pregnancy the embryo does not fill the uterine cavity, and distension has no influence at this stage. An identical uterine enlargement occurs in cases of ectopic pregnancy when the embryo is outside the uterus. The growth is brought about by the action of œstrogen and progesterone. Later on, as the fœtus and placenta become larger, the distension of the uterus provides a further stimulus to growth.

In early pregnancy active mitosis can be seen in the connective tissue and muscle cells, and the enlargement of the uterus is largely due to an increase in the number of cells. Later in pregnancy the enlargement is chiefly due to hypertrophy of the individual cells, and cell division is less active. At term each muscle cell is about ten times as long as it was before pregnancy. The blood-supply to the uterus is greatly increased, and especially under the placental site the veins become converted to large sinuses, thicker than a pencil. Section of the nerve supply to the uterus has no effect on the growth of the uterus in pregnancy.

At the 12th week of pregnancy the body of the uterus is roughly spherical. Examination of the uterus at this stage will show that the lowest part of the body of the uterus, the part just above the internal os, forms a short narrow canal, sometimes termed the isthmus. At first the isthmus does not contain any part of the embryo, but as pregnancy proceeds the isthmus becomes stretched, and the embryo comes to occupy this part of the body of the uterus as well as the main cavity. The isthmus thus forms the *lower uterine segment*, and this is the part of the body of the uterus which will be stretched during labour by the more powerful contractions of the upper segment. In many cases the formation of the lower segment begins in late pregnancy and before labour starts, and at this stage the lower part of the uterine cavity has the form of a half sphere, with the internal os at its lowest point. During labour this half sphere will be converted into a cylinder which is continuous with the cervical canal. In most cases the lower segment is represented by that part of the full-time uterus which is within a radius of 7·5 cm. (3 inches) from the internal os, but it must be recognized that the distinction between the upper and lower uterine segments is physiological, rather than one that is capable of precise anatomical definition.

At term the wall of the uterus appears thin in relation to the enormous enlargement of the cavity, but in fact it is still about 1 cm. (just under half an inch) thick. In late pregnancy it is possible to define three layers in the muscular wall of the uterus:

1. There is a thin outer layer of fibres that arch over the fundus, and are continuous laterally with the muscle of the round ligaments.

2. There is a thick intermediate layer, consisting of a meshwork of interlacing fibres, which pass around the blood-vessels. The contraction of this layer will stop the blood-flow in the vessels, and it is the strong contraction of this layer which prevents dangerous hæmorrhage from the large placental sinuses in the third stage of labour.

3. The inner layer is thin, and arranged in a circular fashion, especially around the internal os and around the tubal openings.

During pregnancy the uterus contracts from time to time (Braxton Hicks contractions), and contractions can be stimulated by handling the uterus. The contractions are not so strong or so sustained as those of labour, and are painless.

The peritoneal coat grows to keep pace with the enlargement of the uterus. It preserves its usual relations to the uterus in front and behind, but at the sides the gradual distension of the lower segment has the effect of separating the layers of the lowest part of the broad ligament, so that its level is raised and a larger area at the side of the uterus is uncovered by peritoneum than in the non-pregnant organ.

The ovarian and uterine arteries and veins are greatly enlarged, and the latter become straighter in their course up the side of the uterus.

Cervix. Although the cervix hypertrophies to some extent during pregnancy, it does not do so to anything like the same extent as the body of the uterus. Three important changes occur in it, namely, the hypertrophy of the glands of the cervical canal, the softening of the cervix, and the bluish colour that it assumes. Softening of the cervix begins in the early weeks, but its degree varies. It is due to increased vascularity and to a great increase in the gland spaces. The glands are distended with mucus, and the pattern of the glands becomes far more complex, so that the cervix seems to contain a honeycomb filled with mucus. This is sometimes described as a mucus plug, but the mucus is in the gland spaces, not free. The bluish colour is due to venous congestion, and appears earlier than the similar appearance in the vagina.

The cervical canal is normally still present at the end of pregnancy, although in many multiparæ the external os is patulous. An intact and effective internal os is of importance in retaining the embryo safely; with an incompetent cervix there is a considerable risk of abortion, or of premature rupture of the membranes.

Because of the great activity of the columnar epithelium of the cervix, and the increased secretion of mucus, it is common for the stratified epithelium on the vaginal surface of the cervix to be replaced by an

outward extension of the columnar epithelium—one type of cervical erosion. Such an appearance is hardly to be regarded as abnormal during pregnancy, and it will usually disappear in the puerperium.

Vagina and vulva. The increased vascularity already described in the cervix affects the vaginal walls a little later, and they eventually show the violet coloration right down to the vulva. The vaginal walls become softened and relaxed, and the same change occurs in the perineal body.

The watery transudation that normally occurs through the vaginal wall is increased during pregnancy. The hypertrophied cervical glands secrete more mucus, and this is added to the vaginal transudate and desquamated vaginal cells, so that the total discharge from the vagina is increased. The secretion is usually acid in reaction (pH 4·5 to 5) and is some protection against ascending infection.

As pregnancy advances the vulva shares in the increased vascularity, and shows some swelling in consequence. The violet colour is seen on the moist surfaces around the urethra and inner parts of the labia minora, and varicose veins may appear.

Breasts. During pregnancy the secretion of œstrogen in large amounts causes activity and thickening of the skin of the nipple, and active growth and branching of the underlying ducts. The added action of progesterone causes further hyperæmia, and proliferation of the glandular epithelium of the alveoli. Neither of these hormones causes the active secretion of milk, which only begins after delivery, when the level of œstrogen falls and another hormone—prolactin from the anterior lobe of the pituitary gland—is secreted.

Slight changes in the breasts occur in the menstrual cycle, under the influence of œstrogen and progesterone, and the breasts may become tense and uncomfortable for a few days before the onset of the period. If pregnancy occurs these changes are more marked. The earliest change is a swelling of the breasts, especially at the periphery. The lobules of the gland can be felt easily and are harder than normal, these changes producing a knotty feeling in the breast. At the same time the breasts become a little tender, and the patient often describes a 'prickly' sensation in them. The increased blood-supply is shown by a very obvious network of veins under the skin. As a result of congestion, followed by actual growth of the glandular tissue, the breasts become more prominent.

By about the 12th week of pregnancy the glands begin to secrete an almost clear fluid, which can be made to appear at the nipple in droplets if the breast is squeezed towards the nipple. Towards the end of pregnancy the secretion becomes more copious and is yellow in colour and creamy in consistence. It is then known as colostrum, and consists of water, fat,

albumin, salts and colostrum corpuscles. The latter are cells shed whole from the gland acini, and filled with fat droplets. When the milk secretion is eventually established colostrum corpuscles are not found in it, because the fat is discharged from the secreting cells into the lumina of the acini, and the cells themselves are not detached.

Changes also occur in the nipple, which becomes larger and more readily erectile. The areolar skin is active and slightly raised above the surrounding skin. The areola becomes pigmented to a greater or less degree, the change being most marked in brunettes. Once the pigmentation has occurred it persists as a permanent change. The sebaceous glands on the areola are very active in pregnancy, and can be seen as a ring of about 12 to 20 small tubercles (Montgomery's tubercles).

At about the 20th week of pregnancy, in dark skinned women, further pigmentation may occur on the skin beyond the margin of the areola. This is termed the secondary areola, and is not a uniform pigmentation, but takes the form of patchy streaks. The secondary areola is not a permanent change, and it disappears after pregnancy.

The stretching of the skin over the breasts may produce striæ like those which occur on the abdomen (see below).

Sometimes outlying lobules of mammary tissue are found in the axillæ; they enlarge during pregnancy and may form comparatively large swellings. Sometimes such breast tissue has inadequate drainage to the main duct system, and so may become tense and painful when lactation begins.

Abdominal wall. The muscles of the abdominal wall become stretched to accommodate the enlarging uterus, and although in perfect health subsequent recovery is complete, in not a few multiparæ some loss of tone of these muscles persists. In late pregnancy the umbilicus may be flattened out, or even protrude.

Stretching of the abdominal skin may cause the formation of striæ gravidarum. These are due to rupture of the elastic fibres of the skin, and they appear as curved lines, roughly concentric with umbilicus, which may extend to the loins or thighs, and may sometimes occur on the breasts. At first the striæ are pink or red, but after delivery they become silvery-white, and are then called lineæ albicantes. After the first pregnancy the striæ are apt to become pigmented in any subsequent pregnancy. Not all women develop striæ; perhaps one-third do not. It is unusual to see striæ in other conditions in which the abdominal wall is stretched, such as large ovarian cysts, ascites or gross obesity. The fact that they are frequently seen in Cushing's syndrome, when there is a high level of glucocorticoids in the blood, as there is in pregnancy, has led to the suggestion that the striæ are partly due to the action of these hormones.

Pigmentation of the line from the pubes to the umbilicus (the linea

nigra) may be seen in dark-skinned women during pregnancy, and tends to persist in part after the pregnancy.

Pelvic joints. The pelvic hyperæmia causes some softening and slight relaxation of the ligaments of the sacro-iliac joints, and of the ligaments and fibro-cartilage of the symphysis pubis, and the mobility at these joints is slightly increased in pregnancy. In some animals a specific hormone relaxin, probably derived from the ovary, causes relaxation of the pelvic joints, but it is uncertain whether such a hormone plays any part in human physiology.

The changes so far described have mostly been those directly related to the genital tract and the breasts. Numerous other changes occur in the rest of the body, and nearly every system is involved in some change. Yet pregnancy is a physiological and not a pathological process, and many women both feel and appear to be in better general health during pregnancy than at other times. Given good previous nutrition and sound emotional adjustment, the physiological changes of pregnancy are not to be regarded as a strain on the mother's health, but merely as a temporary adaptation to a normal activity.

Maternal metabolism during pregnancy. *Weight gain.* The body weight increases during pregnancy. The total gain varies between 14 and 34 pounds in normal cases, with an average of 24 pounds. Of this total only about 2 pounds are gained during the first trimester; the subsequent average normal gain is of 0·8 pounds per week.

A total gain in weight of 24 pounds would largely be due to the weight of the fœtus and the structures that support it. A fœtus weighing 7½ pounds. a placenta of 1 pound, amniotic fluid wighing 1½ pounds, a uterus of 2 pounds, and an increase in the weight of the breasts of about 2 pounds would account for a total gain of 14 pounds. The remaining gain of 10 pounds represents the weight gained by the rest of the maternal tissues, and this is partly due to fluid retention (3 pounds), and partly due to increase in the body fat and protein.

During pregnancy, apart from the fluid retained in the fœtal tissues, there is some retention of fluid in the maternal tissues, chiefly in the extracellular components, including the blood-plasma (see below). Corresponding quantities of sodium are retained, and at present it is believed that this retention of salt and water is due to the high concentrations of sex steroids during pregnancy, although the part played by suprarenal mineralo-corticoids has not yet been fully investigated.

In cases of pre-eclamptic toxæmia there may be an abnormal gain of weight due to retention of fluid. (See p. 167.)

Metabolic changes. The total metabolic rate of the pregnant woman is increased by between 5 and 25 per cent, but if allowance is made for

the fœtal metabolism the basal metabolic rate of the maternal tissues is probably unaltered.

The total need for calories during pregnancy is increased, but not always to the degree that the patient's appetite may suggest. Apart from fluid retention in cases of pre-eclamptic toxæmia, abnormal weight gain during pregnancy and the puerperium is often due to simple overeating, chiefly by an excessive intake of carbohydrate.

During pregnancy the renal threshold for the excretion of sugar from the blood is sometimes lowered, so that glucose may appear in the urine although the blood-sugar is normal. This condition is of no importance, but it must be distinguished carefully from diabetes, by a blood-sugar curve if necessary. (See p. 275.) Patients with a simple lowering of the threshold are not prone to develop diabetes later. The escape of sugar may only be the result of an increased rate of glomerular filtration, which allows so much sugar to enter the tubules that they fail to absorb it sufficiently.

Lactose may appear in the urine during lactation, but it is hardly ever found during pregnancy.

During pregnancy a high protein intake is required to supply the growing fœtus, placenta, uterus and breasts. Yet during pregnancy large quantities of nitrogen are retained, over and above the amounts required by these structures.

Changes in fat metabolism during pregnancy are less well understood, but the blood fat content is slightly increased, and there is a greater tendency to ketosis if there is any disturbance of carbohydrate metabolism.

The maternal diet must not only supply the protein, carbohydrate and fat required, but also the essential minerals and vitamins. An ordinary diet provides adequate amounts of most of these substances, but in the case of two substances, iron and calcium, there is some risk of a deficit, particularly in the last trimester when the fœtal uptake is greatest. The fœtal body at term contains about 25 g. of calcium, but even with this large demand a mother with a first-class diet will increase her calcium reserve during pregnancy. However, with a less favourable diet there may be a deficiency during the last trimester of pregnancy, when over two-thirds of the fœtal uptake occurs, and this deficiency is supplied by some degree of decalcification of the maternal skeleton and dentine.

In the case of iron only about 1 mg. of iron is assimilated per day, an amount insufficient to meet the fœtal needs, which may reach 4 mg. daily in late pregnancy. In addition the mother herself forms extra red cells during pregnancy. The blood-volume is increased, and although the amount of hæmoglobin per millilitre may be reduced, the increase in blood-volume outweighs this, so that the total amount of hæmoglobin in the maternal body is in fact increased. Even in health, and with a normal

diet, the maternal iron reserves in the liver, spleen and marrow, may therefore be reduced in pregnancy. Not all the iron so used is lost; apart from the hæmoglobin of the fœtus and the maternal blood lost at delivery, the iron built up into excess maternal red cells during pregnancy is later returned to the reserves. The details of the changes in the maternal blood may now be discussed.

Changes in the blood. The total blood-volume is increased during pregnancy by about 30 per cent. The uterus, and the maternal blood spaces in the placenta, contain a large volume of blood, perhaps 800 ml. The increase in blood-volume is an adaptation to supply the needs of this new vascular bed. Although the total number and volume of red cells increase, the plasma volume increases to a relatively greater extent, with the result that the blood appears to become more dilute, and the red cell blood count and hæmoglobin concentration fall. A red cell count of 4 million per c.mm. and a hæmoglobin concentration of 12 g. per 100 ml. (80 per cent) are usually accepted as normal during pregnancy. Yet in spite of the fact that such levels are commonly observed in apparently healthy women in pregnancy there is much evidence to show that if the iron reserves are high before pregnancy, which is seldom the case, or if added iron is given in a form that is well absorbed, then the red cell count and hæmoglobin concentration will remain much higher.

A very high leucocytosis is often observed in labour and the early puerperium, but not during normal pregnancy, when the count does not exceed 11,000 per c.mm. The platelet count is normal. The erythrocyte sedimentation rate is much increased in normal pregnancy.

Changes in the circulation. The cardiac output rises considerably during pregnancy, usually rising about 50 per cent by the 30th week. The output does not then rise much further, and after the 36th week there is a steady fall in the output, so that at term it is little above the normal level. This point is of practical importance in the management of cases of cardiac disease in pregnancy, for in the last month of pregnancy the risk of failure is much less than in the period between the 30th and 36th weeks.

The blood-pressure does not rise in normal pregnancy—indeed it may fall slightly in the middle trimester—and the pulse-rate is not significantly altered, so that the increased cardiac output must be achieved by the expulsion of an increased volume of blood from the heart at each beat. This extra cardiac work is well within the reserve of the normal heart, and little hypertrophy is evident. The heart is displaced upward in late pregnancy, and the apex is rotated outward, so that the apex beat is displaced outward and the electrical axis is altered. There may be left axis

deviation and inversion of the T-wave in an electrocardiograph, but there is little evidence of muscular hypertrophy.

The large blood flow through the uterus may be regarded as an arterio-venous shunt across the main circulation, and the increase in cardiac output and in the blood volume may be related to this. In addition there is some dilatation of the peripheral vessels; the hands and feet are often noticeably warm during pregnancy, and the capillaries of the skin can be shown to be dilated.

The enlarging uterus interferes with the venous return from the legs, so that there is some stasis in the large veins, and slight œdema of the ankles may occur, even in normal cases. Hæmorrhoids and varicose veins may appear for the first time or become worse during pregnancy.

Changes in the respiratory system. Some breathlessness is common in normal pregnancy, especially just before the 36th week. After that, if the fœtal head descends into the pelvis, the breathlessness is often less, a change that the patient may describe as 'lightening'. During late pregnancy the diaphragm is elevated and the lower ribs are lifted outward. The pulmonary ventilation is increased, but the vital capacity is not reduced.

Changes in the alimentary tract. The most striking change in the digestive function in pregnancy is nausea or morning sickness, which occurs in greater or less degree in 70 per cent of pregnant women. As a rule it begins at the 6th week and stops spontaneously before the 14th week. It is generally limited to the early morning, when the patient feels sick or vomits immediately after she gets out of bed. Most women have no further sickness during the rest of the day, but in a few instances the nausea recurs at intervals, or may only occur in the evening. In the morning the vomit usually consists of only a little bile-stained mucus. So long as the vomiting is confined to the morning and little food is lost, and provided that it stops before the 14th week, it is of little consequence, and hardly to be regarded as abnormal, but cases of excessive or prolonged vomiting are certainly pathological. (See hyperemesis gravidarum, p. 211.)

The cause of morning sickness is not certainly known. The most acceptable of the many theories that have been brought forward to explain this symptom is that it is due to the high level of chorionic gonadotrophin in the blood in early pregnancy. The concentration of gonadotrophin falls considerably after the 12th week, when the vomiting starts to improve. Sickness is more severe in cases of twins and of hydatidiform mole, in both of which the level of gonadotrophin is high.

The fact that morning sickness, or at least nausea, occurs in so many pregnant women, and only troubles them in the morning, are obvious

objections to the idea that it is entirely due to neurosis. On the other hand, the exaggeration of this symptom to become excessive and prolonged vomiting is sometimes due to a neurosis. (See p. 211.)

As a rule the appetite is good during pregnancy, but minor digestive upsets are common. Sometimes gastric or intestinal distension occurs, and especially in early pregnancy this causes a feeling of abdominal enlargement, which may give rise to a false idea of the stage to which the pregnancy has advanced. Heartburn is a common complaint, and is due to some degree of relaxation of the cardiac sphincter of the stomach. In a few of the more severe cases this symptom is found to be due to the presence of a hiatus hernia of the diaphragm. The emptying time of the stomach is prolonged during pregnancy (and even more so during labour, a fact that is of considerable importance with respect to the risk of vomiting during anæsthesia). The gastric acidity is often reduced during pregnancy.

Constipation is a common symptom, and this, together with the pelvic hyperæmia and the pressure of the enlarging uterus, may lead to the formation or increase in size of hæmorrhoids.

Changes in the urinary tract. Frequency of micturition occurs in the first 12 weeks of pregnancy, when the enlarging uterus is still in the pelvic cavity and rests on the bladder. It may also occur in the last month of pregnancy when the presenting part is engaging in the pelvis.

Important changes in the renal tract can be seen if an intravenous pyelogram is performed during pregnancy. From about the 16th week of pregnancy onwards, there is considerable and progressive dilatation of the renal pelves and of the ureters down as far as the level of the pelvic brim; these changes are usually greater on the right side. Direct measurement of the intra-ureteric pressure shows that it is lowered rather than raised, and the dilatation is chiefly due to loss of muscle tone, although pressure by the enlarging uterus may explain the greater degree of change on the right side. These changes are important in relation to pyelitis in pregnancy. (See p. 257.) The dilatation disappears during the puerperium, so long as there is no infection of the tract. It is thought to be due to placental hormones, probably progesterone.

Changes in the skin. Many changes in the skin can be seen during pregnancy. The striae gravidarum and linea nigra of the abdomen, and the primary and secondary areolæ of the breast, have already been mentioned.

Pigmentation also occurs on the face, mainly on the forehead or cheeks, as irregularly shaped brown patches, known as the chloasma, or the mask of pregnancy. Such patches completely disappear after delivery. The cause of the widespread pigmentation in pregnancy is not certainly known, but it may be related to suprarenal hormones.

Small spider nævi often appear temporarily during pregnancy, and also palmar erythema, and these are due to the high level of œstrogens.

Changes in the nervous system. Changes in emotional disposition frequently occur in pregnancy, and are to be expected as the mother is developing a new set of relationships to her expected child. A woman who is pleased to bear her child is usually contented and happy, but in the case of a patient who does not really welcome the pregnancy, and perhaps resents the responsibility and alteration of her life that its coming entails, numerous symptoms of emotional origin may appear, and she will make the worst of any discomfort, such as morning sickness. In general, such changes are trivial, and any gross change in personality or behaviour should be regarded more seriously, as a possible indication of mental illness.

Peripheral neuritis due to deficiency of vitamin B_1 (aneurine) is a rare complication of pregnancy, but hardly to be included as a normal physiological change. A more common disorder is acroparæsthesia of the hands, in which there is a sensation of pins and needles with some sensory loss, and sometimes evident weakness of the small muscles of the hands. The patient finds it difficult to use her hands for fine work. Acroparæsthesia has been attributed to œdema in the carpal tunnel involving the median nerve, and this may explain the cases in which the signs have the appropriate distribution, but in other cases the ulnar border of the hand is chiefly involved, and sometimes even the forearm, and in these cases pressure on the lowest part of the brachial plexus near the first rib must be considered. There may be some sagging of the shoulder girdle in pregnancy, sometimes due to enlargement of the breast.

CLINICAL SIGNS AND DIAGNOSIS OF PREGNANCY

The duration of pregnancy. In cases in which pregnancy has followed a single coitus the average duration of pregnancy from the date of intercourse is 266 days. If the calculation is made from the first day of the last menstrual period the average duration is 280 days, and these observations support the belief that ovulation most frequently occurs at the 14th day of the menstrual cycle. However, there is considerable variation in the duration of apparently normal pregnancy, even in cases in which the menstrual cycles were previously regular and of normal length, and also in cases in which the date of a single coitus is known. The method of estimating the probable date of delivery is discussed below. (See p. 66.)

SYMPTOMS OF PREGNANCY

Amenorrhœa. Amenorrhœa is the earliest symptom of pregnancy. In a healthy woman whose menstrual periods were previously regular, if there is a sudden cessation of the periods the presumption must always be that she is pregnant unless some other cause can be found. Amenorrhœa has not the same significance in the case of a woman whose periods were previously irregular, nor may it have any significance in a woman of menopausal age. On the other hand, pregnancy has been known to occur in a young girl before a menstrual period has been observed, and it may arise during a period of amenorrhœa, for example during lactation.

Difficulty can also arise if there is bleeding during early pregnancy. Such bleeding may come from the cavity of the uterus at the stage before the decidua capsularis fuses with the decidua vera, but is not to be regarded as menstrual bleeding. Although a pregnancy accompanied by slight bleeding in the early weeks may prove to be quite normal, such bleeding should always be viewed as a threat to miscarry.

Morning sickness. Morning sickness may start at the 6th week. It is not seen in all pregnant women, and it may be due to other causes, such as alcoholic dyspepsia.

Breast symptoms. In the first 4 weeks of pregnancy the patient may notice some tenderness of the breasts, and some fullness. These symptoms are far from constant, and these too may be due to other causes, such as chronic mastitis.

Frequency of micturition. During the first 12 weeks, when the uterus is still a pelvic organ, there is often some frequency of micturition, because the enlarging uterus presses on the bladder slightly, particularly in the daytime when the woman is standing.

Abdominal enlargement. Many women state that they notice some abdominal fullness in early pregnancy, at a stage when the uterus is not much enlarged. Such a symptom at this stage can only be due to slight intestinal distension. Later on the uterine enlargement becomes evident, and sometimes it is this that first brings the patient to the doctor, especially in a case in which the menstrual history was irregular. On the other hand, a woman sometimes considers herself to be pregnant because of an abdominal swelling due to some other cause, such as fat.

Quickening. The pregnant woman usually first notices movements of the fœtus at between the 18th and 20th weeks of pregnancy, but multiparæ may recognize the movements about 2 weeks earlier. At first the movements are slight, and may be confused with movements of wind in the intestine. This symptom is not of much value in the diagnosis of pregnancy, as the patient who believes herself to be pregnant will often declare that she feels movements. It is of more use when the possibility of fœtal death has arisen in late pregnancy, but even here the patient's statements may be coloured by her hopes or fears.

Tiredness. This symptom, admittedly vague, is a common feature of pregnancy, particularly in multiparæ.

SIGNS OF PREGNANCY

It will be seen that it is not possible to establish a certain diagnosis of pregnancy from any of the symptoms given above, although a combination of them may be strongly suggestive. In every case a proper examination to discover confirmatory physical signs is required. The clinical diagnosis of pregnancy, especially in the first half of pregnancy, depends on a combination of symptoms and signs. Only when the pregnancy has advanced far enough for the parts of the fœtus to be felt clearly, for the fœtal movements to be palpable, or for the fœtal heart to be heard, can the signs be said to be absolute. Other signs are termed presumptive.

It may be mentioned here that demonstration of the fœtal skeleton by X-ray examination is also an absolute sign of pregnancy and, unlike the fœtal heart sounds and fœtal movements, this absolute sign will still be present if the fœtus is dead.

A general description of the signs and investigations during pregnancy will first be given, and then the chronological order of their appearance can be summarized.

Signs due to changes in the uterus. The earliest alteration in the uterus that can be detected as a rule is slight *enlargement of the body of the uterus.* This sign is of little value in the case of a patient who has been pregnant before, but it may be significant in a first pregnancy. The body soon becomes globular, and as progressive enlargement occurs the diagnosis becomes more evident.

Softening of the uterus, due to increased vascularity, is a helpful sign, for although there are many other causes for enlargement of the uterus they do not as a rule lead to softening. The softening may follow a certain
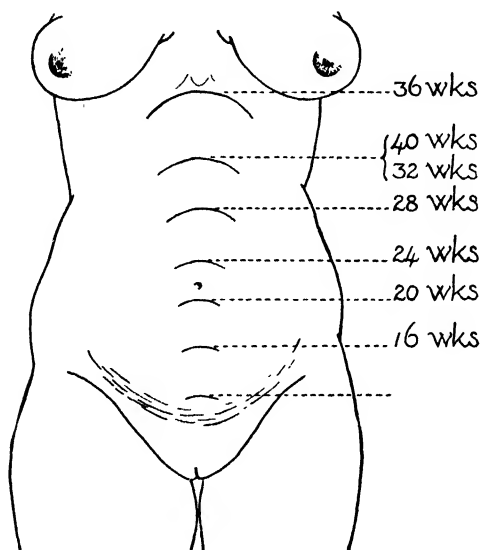
FIG. 19. Height of fundus.

pattern. The isthmus of the uterus (the lowest part of the body) softens first, and until about the 9th week on bimanual examination the globular fundus may feel quite distinct from the still unsoftened cervix. Formerly *Hegar's sign* was elicited by firm bimanual palpation at this stage, when the soft and empty isthmus was compressed, so that the examiner had the impression that the cervix and body of the uterus were separate, but deliberate attempts to elicit this sign should never be made, as they may well cause a miscarriage.

Softening and blue discoloration of the cervix soon follow, and are usually complete by the 16th week. When these changes are well marked they are fairly reliable signs of pregnancy, but softening does not invariably occur, and the cervix sometimes remains firm throughout pregnancy.

By the 10th or 12th week the uterus is usually palpable in the abdomen

just above the symphysis pubis, and *progressive enlargement* then occurs. (See Fig. 18.) The fundus reaches the level of the umbilicus at about the 22nd week, and is just below the ensiform cartilage at the 36th week. If the presenting part of the fœtus then sinks into the pelvis the fundus descends slightly, so that at full time it is again at the level that it occupied at the 34th week. The level of the fundus may be higher than expected from the duration of pregnancy in cases of multiple pregnancy or hydramnios, and at a lower level than expected with an abnormal, dead or ill-developed fœtus.

The pregnant uterus varies in consistence on palpation because it undergoes *painless contractions*. If the patient is easy to examine this variation in consistence may be noticed even when the uterus is still a pelvic organ. When the uterus rises up into the abdomen the contractions are more easily felt, and are very reliable evidence that any swelling under examination is in fact the uterus.

Because the blood flow through the vessels in the broad liagament is greatly increased during pregnancy, on auscultation with a stethoscope pressed firmly against the side of the uterus the *uterine souffle* may be heard. This can be detected at any time after the 16th week, but cannot invariably be demonstrated. It is a blowing murmur, synchronous with the maternal pulse. It is not diagnostic of pregnancy, as it may also be heard in some cases of large uterine fibromyomata.

Signs due to the presence of the fœtus. From the end of the 16th week until about the 30th week the sign known as *ballottement* may be elicited. It depends upon the fact that during this phase of pregnancy the fœtus is floating in a relatively large amount of liquor amnii. It may be elicited by vaginal examination, when it is spoken of as internal ballottement, or by abdominal examination, when it is called external ballottement.

Internal ballottement is felt by placing a finger in the vagina with the patient on her back, when the fœtal head is felt through the anterior fornix. It is then pushed upward with a brisk movement, and can then be felt to float away and then fall back on the finger with a distinct tap.

External ballottement is elicited by placing the patient on her side. One hand is placed under the abdomen and the other above it. The lower hand then jerks the fœtus upwards and recognizes the impact as it falls back. Neither method of ballottement should be employed with any vigour for fear of causing placental separation.

In late pregnancy the fœtal head may be ballotted during the abdominal examination of a case of breech presentation, when the head can be felt to move between two hands at the sides of the fundus.

Abdominal *palpation of fœtal parts* is usually possible from the 24th week ,onwards, and at a later stage the definite recognition of such

structures as the head, back and limbs of the fœtus is an absolute diagnostic sign of pregnancy.

During palpation the *fœtal movements* may be felt, and this too is an absolute sign. Not only may the movements be felt, but they can sometimes be seen if the patient is not too fat.

On auscultation of the abdomen the *fœtal heart sounds* may be heard at some stage after the 24th week. The fœtal heart rate varies between 120 and 160 beats per minute, and is therefore at roughly double the rate of the maternal beat. The sounds are said to resemble the ticking of a watch under a pillow; there is a double sound to each beat, but the sounds are softer and of a different pitch from the maternal sounds. The sounds are most easily heard with a stethoscope with a wide bell.

Before the 30th week the fœtal heart is most often heard in the centre of the abdomen near the fundus. In the later months in vertex presentations it is best heard about one-third of the distance along a line from the umbilicus to the anterior superior spine of the ilium. In breech presentations it is heard at the level of or just above the umbilicus on the upward prolongation of this line on either side.

The *funic souffle* is occasionally heard when the stethoscope happens to lie directly over the umbilical cord, and is a soft blowing murmur, synchronous with the fœtal heart.

Signs due to changes in the breasts and the skin. The changes in the breasts in pregnancy have already been described (see p. 49) but may be summarized here. The earliest sign is due to proliferation of the peripheral lobules of the breast, which may give rise to a knotty feeling at the edge of the gland. Pigmentation of the areola of the nipple occurs before the 8th week, but may be very slight in fair women. This *primary areola* persists after the first pregnancy, so that the sign is useless in the diagnosis of any subsequent pregnancy. The sebaceous glands around the areola become enlarged to form a ring of small tubercules (*Montgomery's tubercules*), and the subcutaneous veins over the breast become dilated, but these changes are not always sufficiently clear-cut to be diagnostic.

By the 12th week a clear secretion can usually be expressed from the nipple, but this sign too is only of value in a first pregnancy, as secretion can often be expressed from the breast of any patient who has once been pregnant, even when she is not again pregnant.

In a second or subsequent pregnancy only one change in the breast is absolutely diagnostic, and that is the appearance of the *secondary areola*, which is a patchy pigmentation of the skin outside the primary areola. This only occurs in dark-skinned women, and after the 20th week of pregnancy. It fades during the puerperium.

The appearance of *striæ on the abdomen* and the *linea nigra* have already

been described (see p. 50), but these are also only helpful in the diagnosis of a first pregnancy, as they tend to persist afterwards. In a subsequent pregnancy striæ in the abdomen may become freshly pigmented.

RADIOLOGICAL DIAGNOSIS OF PREGNANCY

The demonstration of fœtal bones in an X-ray photograph is a certain method of diagnosing pregnancy. With a good plate, and a patient who is not too fat, a positive result may be expected from the 16th week onwards. It is, however, undesirable to use this method in early or mid-pregnancy, when it is thought that the fœtus is particularly susceptible to the effects of radiation.

TESTS FOR PREGNANCY

These tests depend on the fact that during pregnancy the trophoblast of the embryo secretes large quantities of gonadotrophic hormone, and that this chorionic gonadotrophin is excreted in the maternal urine. If some of the urine is injected into one of various species of animals specific changes are produced in the gonads by the chorionic gonadotrophin it contains. The most certain results are obtained if the urine is concentrated, and for that reason the patient is instructed to bring the first morning specimen after having restricted her fluid intake from the previous evening. A catheter specimen of urine is not necessary, but the urine must not be grossly infected.

The original test was that of Aschheim and Zondek, in which the urine was injected into immature female mice. If the urine contained sufficient gonadotrophin to give a positive test the ovaries of the mice were found to contain numerous hæmorrhagic corpora lutea after 100 hours. This method can be used as a qualitative test by using various dilutions of the urine, and is used in this way in the diagnosis of hydatidiform mole. (See p. 248.)

The Friedman test depends on the stimulation of ovulation in the ovaries of rabbits.

Tests now in more general use are the Hogben test, in which the injection of urine containing chorionic gonadotrophin into female Xenopus toads causes the extrusion of ova within 15 hours, and the Mainini test, in which the injection into male toads (*Bufo Bufo*) causes the extrusion of spermatozoa within 6 hours.

The biological tests are particularly useful during the first 12 weeks of pregnancy when the excretion of chorionic gonadotrophin is high, and when the clinical diagnosis may be difficult. During this stage of pregnancy a positive result is nearly always reliable, but occasionally negative results are incorrect, especially if they are performed before the 6th week of

pregnancy. The amount of gonadotrophin excreted after the 12th week falls off, and for that reason the tests are less reliable at that stage.

A point that should be mentioned is that a weak positive result is sometimes obtained just after the menopause because of the high level of *pituitary* gonadotrophin at that time, and unless strongly positive the test should be accepted with reserve in the investigation of amenorrhœa at the age of the menopause.

Immunological tests for detecting human chorionic gonadotrophin are now available and are replacing biological tests because of their speed, sensitivity and convenience.

Another test which has been used consists of the oral administration of a mixture of œstrogens and progestogens for 2 or 3 days. It is claimed that if withdrawal bleeding occurs the patient is not pregnant, but this test is most unreliable.

The simple test of time can still be used and has at least the virtue of being infallible.

CHRONOLOGICAL SUMMARY OF THE SIGNS AND SYMPTOMS OF PREGNANCY

5th–8th weeks. Amenorrhœa, discomfort in breasts, enlargement of the uterus, morning sickness, commencing pigmentation of the areola. Pregnancy tests positive.

9th–12th weeks. Amenorrhœa, morning sickness, frequency of micturition, uterus just palpable per abdomen, pigmentation of the areola, secretion can be expressed from breasts, softening of cervix, coloration of cervix and vagina. Pregnancy tests positive.

13th–16th weeks. Amenorrhœa, morning sickness ceasing, uterus halfway between pubes and umbilicus, pigmentation of areola, Montgomery's tubercles, uterine souffle, internal ballottement, softening of the cervix, coloration of the vagina. X-ray shows fœtal bones.

19th–20th weeks. All the signs and symptoms mentioned for previous month; also quickening, the secondary areola if present, uterine contractions, uterus nearly to umbilicus.

21st–24th weeks. All the above, uterus just above the umbilicus, striæ, linea nigra.

25th–28th weeks. Uterus reaches one-third of the distance between the umbilicus and the ensiform cartilage. All the positive signs, fœtal heart, fœtal movements, uterine contractions.

29th–32nd weeks. Uterus reaches almost to the ensiform cartilage.

33rd–36th weeks. Uterus reaches the ensiform cartilage.

After 36th week. Uterus sinks again to about the position it had reached at the 34th week, fœtal head engaged in primigravidae.

DIAGNOSIS OF PREGNANCY

Certain of the signs of pregnancy are absolute, namely, hearing the fœtal heart sounds, the manual appreciation of fœtal parts and movement, and radiological demonstration of fœtal bones. Detection of any one of these makes the diagnosis of pregnancy certain. Since, however, the first signs only occur with a live fœtus, the X-ray affords the only sign that is absolute under all conditions. Nevertheless, radiological diagnosis is undesirable because of the possible adverse effect of radiation on the fœtus.

Certain other of the signs though not absolute are very strongly presumptive, namely, a positive result of the biological pregnancy test. The pregnancy test is of practical usefulness from the 7th week, but taking positive and negative results together there is an error of about 1 per cent.

Uterine enlargement corresponding to the period of amenorrhœa during the period of reproductive life is strongly presumptive of pregnancy, since practically all the enlargements of the uterus during this period are accompanied by increased menstrual loss, or at least, no diminution of it. This syndrome is available for diagnosis from the 8th week onwards, and when its significance is reinforced by a positive result to the pregnancy test, it may be taken as an absolute indication of pregnancy.

In some pregnant women the size of the uterus and the period of amenorrhœa do not correspond, since conception may take place during a period of amenorrhœa, or intra-uterine death may occur and amenorrhœa persist. In such patients the uterus will be smaller than the duration of amenorrhœa suggests. Conversely, the uterus will be larger than the period of amenorrhœa suggests when bleeding, which is mistaken for menstruation, has occurred after conception. Other causes of the excessive enlargement of the pregnant uterus are, multiple pregnancy, hydramnios, hydatidiform mole and the presence of a fibroid in addition to the pregnancy.

The remaining signs of pregnancy are suggestive only. A uterine souffle may be heard occasionally over fibroids; ballottement may be simulated by tumours when, in addition, there is free fluid in the peritoneal cavity; softening of the cervix and coloration in the vagina occur under other conditions.

It follows, therefore, that none of these signs, even taken in conjunction, warrant a certain diagnosis of pregnancy, and their presence should be regarded only as an indication to ascertain whether the absolute signs of pregnancy do or do not exist as well.

DIFFERENTIAL DIAGNOSIS OF PREGNANCY

The enlargement of the uterus caused by pregnancy has to be differentiated from other conditions producing an abdomino-pelvic swelling,

of which the commonest are ovarian cysts, fibroids and a distended bladder. Pregnancy also may be associated with these swellings.

Ovarian cysts. In many cases the uterus of normal size can be palpated bimanually separate from the swelling. The pregnancy test is negative and none of the absolute signs of pregnancy is present. Ovarian neoplasms are only accompanied by amenorrhœa during the reproductive period if they are bilateral and totally destroy the ovaries. A thrill or fluctuation is common with ovarian cysts but is only felt in the pregnant uterus in cases of hydramnios.

Uterine fibromyomata. These tumours when deeply placed in the uterus enlarge it symmetrically as pregnancy does and, though as a rule they are much harder, they are sometimes soft enough to simulate the consistence of the pregnant organ. They are, however, hardly ever associated with amenorrhœa and in most cases are accompanied by severe and increasing bleeding at each monthly period. The pregnancy tests are negative and none of the absolute signs of pregnancy is present.

Distended bladder. The bladder may become enormously distended if there is retention due to a retroverted incarcerated gravid uterus (p. 217). The passage of a catheter will disclose the nature of the swelling.

Pregnancy associated with an ovarian cyst. Two swellings will be present, the pregnant uterus, presenting its usual characters, and the cyst. The signs of pregnancy will be present in accordance with the duration of the pregnancy, but before the fœtal heart and parts can be detected there may be some difficulty in deciding which of the two swellings is the uterus. In some cases they are in such close juxtaposition that it is not easy to distinguish two separate swellings. An X-ray examination may sometimes be justifiable in such cases. A cyst lying in the pelvis propping up the pregnant uterus in front of it may be mistaken for the uterus, and the real uterus for a distended bladder, but the passage of a catheter will immediately make the mistake apparent.

Pregnancy associated with fibromyomata. If the fibroids are small they can easily be mistaken for fœtal parts. A fibroid in the uterine wall is immobile, unlike a fœtal limb which may be felt to alter its position from time to time. If the uterus is stimulated to contract by palpation fœtal parts become more difficult to feel, whereas a fibroid may become more evident. Where there is one large abdominal fibroid, it presents as a much harder part of the abdominal swelling over which none of the uterine signs of pregnancy can be elicited, in contrast with the softer part of the swelling where the pregnancy lies. The fibroid may be in the pelvis with

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the pregnant uterus above it and may even be mistaken for the child's head.

Occasionally a fibroid in the pelvis below the pregnancy may obstruct the bladder so that it becomes greatly distended. A catheter should be passed in all cases in which the diagnosis is in doubt. Early pregnancy is difficult to diagnose in the presence of these tumours and the biological pregnancy tests are of the greatest value.

Pseudocyesis

Pseudocyesis, or spurious pregnancy, is a psychological disorder in which the woman has the false but fixed belief that she is pregnant. The term does not include the uncommon instances of wilful and conscious deception; the patient honestly believes that she is pregnant.

Pregnancy fantasies may occur in gross psychoses, usually cases of schizophrenia, but the more common case of pseudocyesis is not associated with such severe mental illness, but is rather an instance of hysteria.

It is frequently, but not invariably, seen near or after the menopause, and not always in women without children. There may be amenorrhœa, and the patient will declare that she has morning sickness and breast enlargement, and that she can feel fœtal movements. The abdomen may appear distended, either by gas collected in the stomach by ærophagy, by intestinal distension, by persistent contraction of the diaphragm, by exaggerated lordosis or sometimes just by fat. Breast tenderness is sometimes due to chronic mastitis.

The shape of the swelling is not that of the pregnant uterus, and fœtal parts cannot be felt nor the fœtal heart heard. In cases of gross obesity a biological pregnancy test or even an X-ray may be justified. The difficulty is to convince the patient of the truth.

ESTIMATION OF THE EXPECTED DATE OF DELIVERY

Since there is no definite means of knowing the time at which conception occurs, it is usual and convenient to calculate the date on which delivery is to be expected from the first day of the last menstrual period. A simple practical method is to count forward 9 calendar months (or backward 3 calendar months) from the first day of the last period, and to add 7 days. This gives an average of 280 days, with a little variation as the lengths of the calendar months are not uniform. If the previous menstrual cycles were irregular or prolonged no reliance can be put on this method. Even if the previous cycles were regular, in as many as 40 per cent of cases labour begins more than 7 days before or after the calculated date.

An attempt has often to be made to estimate the probable date of delivery when the date of the last menstrual period has been forgotten,

or when conception occurred during a phase of amenorrhœa, for example during lactation. In such cases the observed height of the fundus, especially if repeated observations are available, is the best guide. The date at which the patient first felt fœtal movements (quickening) may also give a rough indication of maturity. Primigravidæ usually feel movements of the fœtus at between 18 and 20 weeks, and multiparæ may recognize the movements a little sooner, but a patient who cannot remember the date of her last period is seldom able to give an accurate report of the date of quickening.

POSTMATURITY

Postmaturity means the prolongation of pregnancy beyond its normal duration, but there is no generally accepted definition or any agreed limit to the duration that can be regarded as normal. The difficulty in making any definition is that the precise date of conception in any particular pregnancy is unknown; even with regular menstrual cycles of normal length the date of ovulation is only approximately known. In cases with irregular or prolonged cycles calculations based on the date of the last menstrual period are bound to be inaccurate.

Apart from the uncertainty of the date of ovulation, it is inherently unlikely that all fœtuses will mature in precisely the same number of days. The cause of the onset of labour at term is also unknown. In animals pregnancy can certainly be prolonged by giving large quantities of progesterone, but there is no evidence that delay in the onset of labour in women is due to this or any other hormonal abnormality. Fœtal anencephaly may be associated with prolongation of pregnancy.

Diagnosis. General statistical statements based on large numbers of cases can easily be made, showing that about 25 per cent of cases of pregnancy will be delivered during the 42nd week, 12 per cent during the 43rd week, 3 per cent during the 44th week, and half of 1 per cent more than 44 weeks after the beginning of the last period, but in any particular pregnancy the diagnosis of postmaturity is usually uncertain.

Only in cases in which the date of the last menstrual period is certain, and in which the previous cycles were of normal length, can the diagnosis be reasonably made. In other cases the evidence is usually too unreliable to justify any action being taken. Observations of the height of the fundus during pregnancy, or of the date of quickening, are not accurate enough to allow of precise estimation of maturity. Not only is it difficult to assess the size of the fœtus in the uterus, but even in normal cases the weight may vary between about 5½ and 10 pounds at term, so that estimates based on the size of the fœtus are also unreliable. The dates of appearance of the ossific centres vary widely. On the whole an accurate and certain menstrual history remains the most reliable guide.

Clinical significance. The delayed onset of labour might, in theory, have two disadvantages: (1) The placental function may become inadequate after term, as the uterine blood flow diminishes and degenerative changes progress. (2) There may be mechanical difficulties during labour due to the increased size of the fœtus, and perhaps the uterus which is slow to begin labour may also prove inefficient during labour.

The risk of the fœtus dying in the uterus from anoxia before the onset of labour in postmature cases has probably been exaggerated, though this does occasionally occur. There is, however, good evidence that the risk of fœtal distress and stillbirth during labour is greater in postmature than in normal cases. In part this is due to more difficult labour, due to the larger size of the fœtus and to inco-ordinate uterine action. The skull of the postmature fœtus is more ossified, and therefore harder, so that moulding is less easy.

Many obstetricians consider that the risk of anoxia in postmature cases is increased if there is also hypertension, and in the case of an elderly primigravida.

Medico-legal significance. Postmaturity may be of great medico-legal importance, as a husband may question the paternity of a child born more than 44 weeks after he left his wife. In law each case is decided on the basis of the medical evidence, and there is no legal definition nor set upper limit for the normal duration of pregnancy. In a recent case a child born 346 days after the last cohabitation was judged to be legitimate, but in another case a child born after 360 days was adjudged illegitimate on appeal.

Management. Postmaturity is often a cause of worry, and sometimes of expense and inconvenience, to the mother, and pressure is often put upon the obstetrician to induce labour. While this may be justifiable in some cases in which the menstrual history is certain, it is most unwise with an uncertain history, when there is a risk that the fœtus may, after induction, prove to be premature rather than postmature.

Since patients and their relatives tend to worry when the date given to them as the expected date of delivery has been passed, it is most desirable that every patient should be told that the calculated date is only an approximation, and that normal labour often starts a week or more later than this date.

Each case of suspected postmaturity must be dealt with according to its special circumstances. There is no justification for making a rule to induce all cases at some stated week of pregnancy; the risks of indiscriminate induction might well exceed those of postmaturity. If the menstrual cycles were irregular or long, or if the date of the last period is uncertain, as the clinical diagnosis of postmaturity is so unreliable there is little justification for any interference.

In other cases, especially those with hypertension, or in those occurring

in elderly primigravidæ, induction may be considered. Induction may also be recommended for a patient with a fœtus that is evidently large, and in whom there is increasing risk of disproportion as the fœtus continues to grow. There can be little justification for induction until the patient is at least a fortnight overdue, except in cases with hypertension.

Labour may be induced in cases of postmaturity by three methods, which are often combined:

1. Reflex stimulation of the uterus by giving an enema and a hot bath is harmless but is usually unsuccessful.
2. The use of oxytocin, either intramuscularly, intravenously or by the buccal route.
3. Artificial rupture of the membranes.

The first method is innocuous, but of doubtful efficacy. Oxytocin used to be given by intramuscular injections of 2 units at half hourly intervals for 6 doses, but the absorption of the oxytocin by this route is erratic and there is a grave risk of uterine rupture. The same objection applies to buccal administration. The more effective method is to give the oxytocin by slow intravenous infusion (see p. 573), but this method requires most careful supervision with frequent observations of the fœtal heart-rate and the strength of the uterine contractions, which would be difficult except in hospital. It may also be used before artificial rupture of the membranes, especially in cases in which the cervix seems to be firm and resistant, and it may sometimes be used if labour does not start after the membranes have been ruptured.

On the whole, if it is decided to induce labour for postmaturity it is best to rupture the membranes forthwith. Other methods are less certain, and if they fail the patient's anxiety may be much increased. If labour does not follow rupture of the membranes within 24 hours an oxytocin drip is often successful.

In any case of suspected postmaturity the careful supervision of the labour is probably more important than the decision whether or not to induce labour. A vigilant watch is kept for any sign of fœtal distress, such as any change in the fœtal heart rate or the passage of meconium into the liquor. In a few cases in which fœtal distress occurs immediate delivery must be effected, either by forceps delivery if the cervix is full dilated, or otherwise by Cæsarean section. It must be remembered that the fœtus is large, and disproportion is a possibility, making any manipulation such as rotation of an occipito-posterior presentation more difficult.

CONDITIONS OF MEDICO-LEGAL IMPORTANCE

The effects of a recent pregnancy. It is sometimes of importance to be able to recognize the effects of a past pregnancy from a medico-legal point of view. The signs of a recent delivery are always clear, but those of

an abortion may not be, and further, a full-time delivery leaves marks on the patient which are indelible for all time, while an abortion may not leave any sign.

The signs of a recent delivery, say within a week or two, are general and local. The breasts will be full and contain milk, and may show striæ. The abdominal wall is usually lax, the skin pigmented and striæ gravidarum are present. The uterus will be enlarged, the size depending upon the time which has elapsed since delivery. The cervix will be soft, somewhat patulous and possibly lacerated. The vaginal walls will be relaxed and inspection may reveal minute tears. The hymen will show deep lacerations through its whole thickness, the remnants being swollen and congested in primiparæ. The fourchette will be torn through in a vertical direction as a rule, and there may be more or less laceration of the perineum and lower part of the vagina. The presence of these lacerations is the most convincing of all evidence that a recent full-time delivery has occurred. The discharge from the external os will be more or less blood-stained according to the degree of involution which has occurred.

It is much more difficult to say with any degree of certainty that abortion has recently occurred. Even at the end of a week after an early abortion very few signs may be found, locally or generally, which could be sworn to as evidence of a recent pregnancy. It is improbable that any laceration or injury of cervix, vagina or vulva would be discovered. The discharge may have ceased, and the pelvic organs may not be congested; but there is usually a lochial discharge for a week or 10 days. The uterus would certainly be enlarged, but it is impossible to say definitely that a slight enlargement of the uterus is due to a recent abortion. It might have been due to a long-past pregnancy. So that unless the patient was seen and examined within a day or two of an early abortion, it is hardly likely that any positive signs would be present. The biological tests for pregnancy remain positive for a variable time after the death of an ovum. In nearly all cases the tests become negative in 48 hours but they may remain positive for a longer period if a piece of living chorion remains attached to the wall of the uterus.

Signs of a long-past pregnancy and delivery near full time. Striæ gravidarum will probably be seen on the abdomen; occasionally, however, they are absent. Also these marks may occasionally be the result of other conditions such as Cushing's syndrome.

The uterus is usually larger than that of a nulliparous woman, but the amount of enlargement is slight. The os uteri is nearly always altered in shape, instead of a circular or oval opening it is a transverse slit. It may show notches, unilateral, bilateral or starred, the result of laceration. It must be remembered that notches in the cervix may be the result of

former surgical treatment, but they are small compared with the laceration caused by labour. The vaginal walls are relaxed and the calibre of the canal enlarged. The hymen has disappeared leaving small protuberances, the carunculæ myrtiformes. Coitus, apart from delivery, injures the hymen, but the lacerations made by it are superficial and do not completely break it up. The fourchette is always torn in a full-time delivery, and the fossa navicularis is flattened out, ceasing to exist as a distinct hollow. A scar in the perineum and general relaxation of the vaginal outlet are very suggestive signs of delivery.

Signs of virginity. It sometimes happens that an opinion has to be given as to the virginity of a woman. It may be a matter of extreme simplicity or may be impossible to decide. For instance, if on vulval examination it is seen that the hymen is absolutely intact, that it only admits the finger-tip, and has a sharp edge which firmly encircles the finger, it is clear that no penetration of anything larger than the finger-tip can have occurred, and a definite opinion can be given that the patient is virgo intacta. If, however, the hymen easily admits one or two fingers, this is not proof that sexual connexion has occurred. If the hymen is notched in several places, is lax and dilated, and one or two fingers pass in easily without the patient's flinching, or experiencing pain, it is possible that coitus has occurred but by no means certain, for the effect of the prolonged use of vaginal tampons for menstrual hygiene is the same.

It must be remembered also that the hymen may be dilated and even notched in this way merely by the passage of a finger during an examination, or that the patient may have had an operation or examination in which a speculum was used, and that even the constant passage of a douche no.-'- may produce the same effect. All that can be said, therefore, in such a case is that something has been passed through the hymen sufficient to stretch or notch it, but it does not follow that these appearances are the result of sexual intercourse.

The signs of a recent first coitus may be more positive. There may be unhealed lacerations of the hymen, the orifice may be reddened and swollen, and may also be acutely sensitive. In the case of a recent attempt at rape, it is usual to look for the presence of spermatozoa in the vagina, or on the clothing of the woman or child. A dried stain on a garment may show the presence of spermatozoa when examined by proper methods. The suspected material is extracted for some hours in a minimal quantity of normal saline. The extract is dried on a slide and stained with hæmatoxylin and eosin which stain the spermatozoa and their heads blue and red. Specific precipitin reactions are also recognized.

THE PELVIS

THE pelvis of an infant is small, even in proportion to the size of the child; it has an almost straight sacrum united to an almost straight spine at a slight angle (the sacro-vertebral angle), hence the promontory is not well marked, and is placed at a higher level than in an adult pelvis. The anterior surface of the sacrum is flat from above downward and also from side to side; it is narrow, because the lateral masses are poorly developed. The iliac fossæ are shallow and look inwards. This infantile pelvis becomes altered by,

1. The growth of the bones.
2. The body-weight acting through the sacrum and resisted by the pressure of the femora on the acetabula.
3. Muscular action and the tension of ligaments.

It may be noted that the second and third causes act equally in the male and in the female and, therefore, the characteristics of a female pelvis must be due to an inherent tendency on the part of the bones to develop along certain definite lines.

However, radiological investigations have shown that variations from the typical female pelvis are not uncommon, and these must not be considered as abnormal. What had been accepted as the normal female pelvis—the *gynecoid pelvis*, is now known to occur in only about 40 per cent of the white population. Of the others, some show male characters, the *android pelvis;* others resemble that of the anthropoid ape, the *anthropoid pelvis;* whereas in the remainder the pelvis is flattened and has been named the *platypelloid pelvis*. (See p. 399.)

Only the gynecoid pelvis will be described here (Fig. 20). In this pelvis the inlet is rounded, except for a slight projection of the sacral promontory, and may be divided into an anterior and posterior segment by a line drawn through the widest transverse diameter.

The posterior half of the inlet is deeper than in the male pelvis because of the increased width of the sacro-sciatic notch below it. The anterior half is also roomy because of the wide angle made by the diverging ilio-pectineal lines. Seen from the front, the gynecoid pelvis has a very wide and shallow sub-pubic angle, and the descending rami of the pubic bones are not so deep as in the male pelvis. The cavity is circular and large. A lateral view of the pelvis demonstrates the typically wide sacro-sciatic notch (Fig. 21). The sacrum is concave on the anterior surface and is inclined backwards. The space between the lower lateral border of the

sacrum and the spine of the ischium is very wide because of the general breadth of the sacro-sciatic notch. This gives roomy measurements in the cavity and makes the sacro-spinous ligament long.
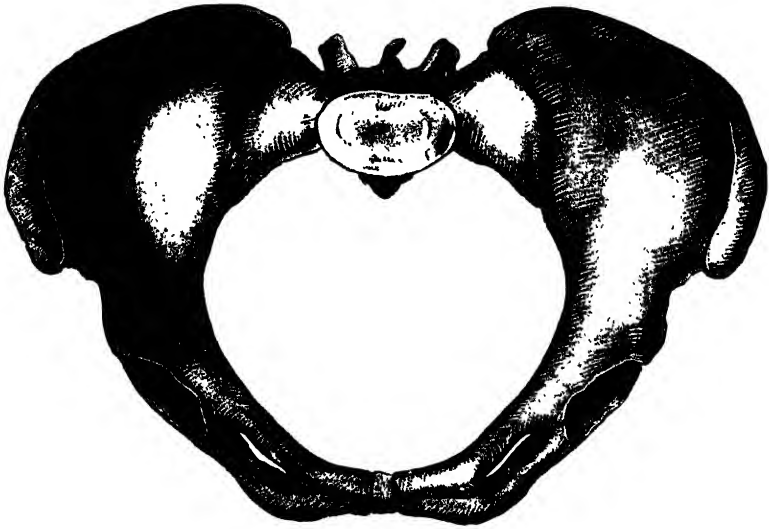
FIG. 20.   Gynecoid pelvis showing the brim.

FIG. 21.   The os innominatum of a gynecoid pelvis showing the wide sciatic notch.

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The outlet is diamond-shaped. The wide sub-pubic angle produces a comparatively large transverse diameter between the two ischial tuberosities. The longest diameter is the antero-posterior and this may be increased by half an inch if the coccyx is movable.

Many small variations in form and size may occur in the gynecoid pelvis, but the general architecture remains the same.

FIG. 22.   Gynecoid pelvis, anterior view.
(Note the wide sub-pubic arch.)

The following account is concerned with the pelvis from an obstetrical point of view, and only those anatomical points which have relation thereto will be dealt with.

The pelvis as a whole

For obstetrical purposes the pelvis is divided by the brim into two parts, the false and true pelvis.

The false pelvis is that portion above the brim. It does not take any part in the mechanism of labour, and is of no obstetric interest. In the past attempts were made to form a judgment of the size of the true pelvis, by measuring the width of the false pelvis. The information thus obtained is often inaccurate and such external pelvimetry has been given up.

The true pelvis, which includes the brim and that portion of the pelvis below it, is divided into the brim, the cavity, and the outlet.

The brim. The brim is formed in front by the upper margins of the pubic bones, at the sides by the ilio-pectineal lines, and behind by the anterior and upper margin of the sacrum.

The cavity. The cavity of the pelvis is irregular in shape, and is formed by the pubic bones in front, the anterior surface of the sacrum and coccyx behind, and the inner surfaces of the ischial and iliac bones at the sides.

The outlet. The outlet, which is more or less diamond-shaped, is formed in front by the inferior rami of the pubic and ischial bones, behind by the tip of the coccyx and the sacro-tuberous ligaments, and at the sides by the ischial tuberosities.

Planes and straits of the pelvis

The true pelvis may be divided into a series of imaginary planes. Two of them, named the plane of the brim and the plane of the outlet, are not strictly mathematical planes and are, therefore, often referred to as the superior and inferior straits.

Plane of the cavity or plane of greatest pelvic dimen-

Superior strait or plane of the brim.

Ischial spine.

Plane of outlet or inferior strait.

Plane of least pelvic dimensions.
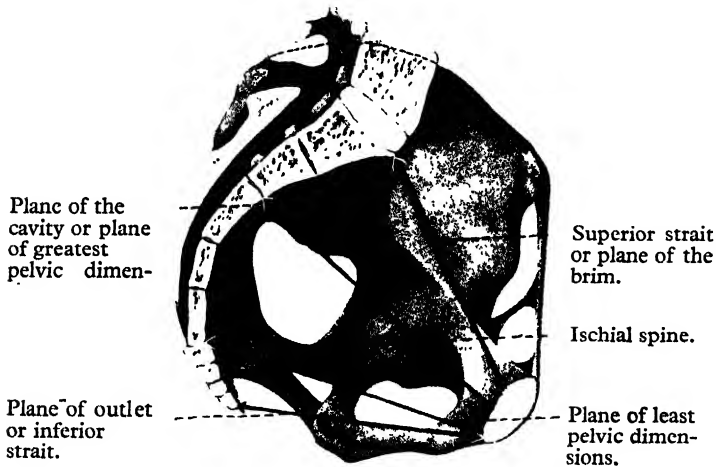
Fig. 23.   Antero-posterior section of the pelvis.
Showing the pelvic planes.

The four planes are, in order from above down (see Fig. 23):
1. The plane of the brim, the pelvic inlet or superior strait.
2. The plane of the cavity or plane of greatest pelvic dimensions.
3. The plane of least pelvic dimensions.
4. The plane of the outlet or inferior strait.

(1) *The plane of the brim* or superior strait is rounded with the projection forward of the sacral promontory posteriorly. Laterally it is bounded by the ilio-pectineal lines, in front by the upper margins of the horizontal rami of the pubes, and of the bodies of the pubic bones and symphysis pubis.

(2) *The plane of the cavity* or plane of greatest pelvic dimensions is limited in front by the middle of the bodies of the pubic bones and symphysis pubis, behind by the junction of the second and third pieces of the sacrum, and laterally it passes through the ischial bones, at the level of the middle of the acetabula.

(3) *The plane of least pelvic dimensions* extends through the lower margin of the symphysis pubis, the tip of the sacrum or sacrococcygeal joint, and laterally through the ischial spines.

(4) *The plane of the outlet* or inferior strait is roughly diamond-shaped and is bounded anteriorly by the lower margin of the pubic arch, posteriorly by the coccyx; laterally by the great sacrotuberous ligaments and ischial tuberosities.

This plane is subject to so much alteration by the movements of the coccyx, that only measurements of the transverse diameter between the ischial tuberosities have much value.

The plane of the brim is obstetrically the first in importance. But second only in importance is the plane of least dimensions, because it is at this level in small gynecoid (generally contracted) pelves and in pelves with a contracted outlet that obstruction is generally encountered. The measurement between the ischial spines is difficult and painful to take, but that from the sacro-coccygeal joint to the lower margin of the symphysis pubis is of practical value when combined with that between the inner margins of the ischial tuberosities and gives as good an estimate of the space available.

The pelvic floor. The pelvic floor consists of the two levatores ani muscles. During the second stage of labour they form a musculo-fascial gutter, with the opening of the vagina looking forwards between the sides of the gutter. The pelvic floor plays an important part in directing forwards the most salient portion of the presenting part under the symphysis pubis. (For a full description of the anatomy of the pelvic floor the reader is referred to *Diseases of Women* by Ten Teachers, 11th Edition, Chapter III.)

The sacro-iliac joints are situated between the articular surfaces of the sacrum and ilium. During pregnancy these joints become softened and are capable of movement. By one of such movements the sacrum is able to rotate backwards or forwards through a transverse axis passing through the centre of the joints, with the results that the size of the inlet or outlet of the true pelvis is diminished or increased accordingly. During the first stage of labour if a woman walks about, the pubes are swung away from the promontory, the size of the inlet of the pelvis being somewhat increased. During the second stage when lying down and flexing her thighs, the swing of the sacrum is reversed and the size of the pelvic outlet is increased. This excursion of the sacrum is more marked at its lower than its upper extremity.

The pubic joint. The symphysis pubis is the joint between the upper and anterior portions of the bodies of the pubic bones. The softening of this joint facilitates the passage of the fœtal head by allowing a widening of the pubic arch and the transverse diameter of the outlet.
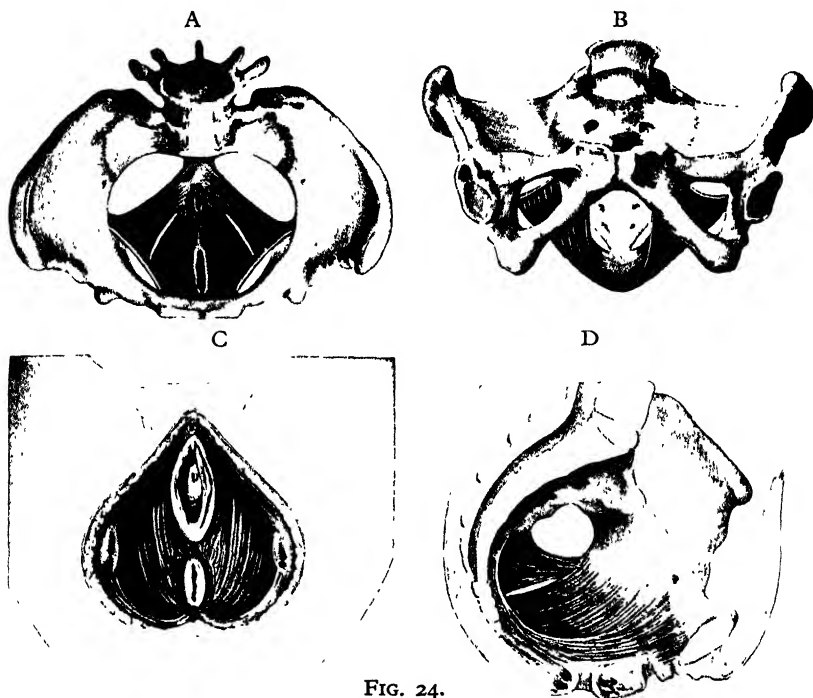
FIG. 24.

A, showing the pelvic floor muscles from above.
B, showing the gutter-like shape of the levatores ani.
C, showing the pelvic floor from below, perforated by the vagina in front and the rectum behind.
D, showing the pelvic floor in sagittal section as seen from the side, with the perineal body between the lower ends of the vagina and rectum.

The sacro-coccygeal joint. This joint, becoming softened during pregnancy, allows the coccyx to be pushed backwards by the fœtal head during its escape from the pelvis, thus enlarging the antero-posterior diameter of the outlet.

When there is ankylosis of the sacro-coccygeal joint, the coccyx has to be taken into account as it then forms the posterior boundary of the obstetrical outlet.

The axis of the pelvis

The axis of the pelvis consists of an imaginary line which would show the position of the centre of the fœtal head in its passage through the pelvis.

Such a line is obtained by taking any number of antero-posterior diameters of the true pelvis, between the plane of the brim and that of the outlet, when a line joining the centres of these diameters will indicate the axis of the pelvis (Fig. 25).
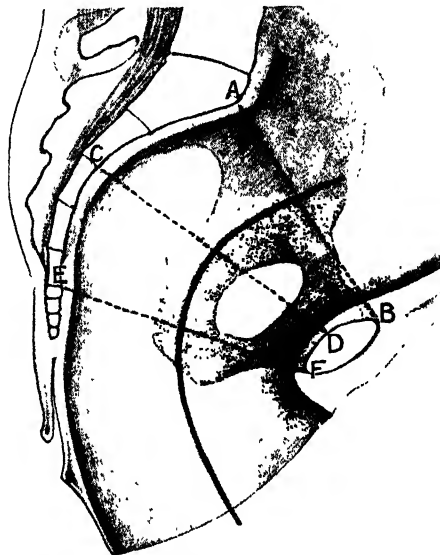
FIG. 25.   The axis of the birth canal.

The black line shows the position of the centre of the fœtal head during its passage through the pelvis. This imaginary line is termed the axis of the pelvis. AB, Plane of brim. CD, Plane of cavity. EF, Plane of outlet.

The inclination of the pelvis

By the inclination of the pelvis is meant the relation of the plane of the pelvic brim to the horizontal. In the erect position the inclination of the pelvic brim forms an angle of 60 degrees with the horizontal. In negro women this angle may approach 90°.

Another way of measuring this is to take the angle between the plane of the inlet and the front of the body of the fifth lumbar vertebra (Fig. 26). The average angle obtained in this way is 135 degrees. This is a more accurate method of measuring the inclination of the pelvic brim. The size and shape of the pelvis may be normal and there may not be any dispro-portion between the size of the fœtal head and the brim, but failure of engagement of the head can occur solely because the inclination of the pelvic brim is abnormally high, for example, in negresses.

The shape, direction and inclination of the sacrum play an important part in providing the necessary space for engagement of the head in the

upper part of the true pelvis. The sacral inclination is measured by taking the angle between the first piece of the sacrum and the plane of the inlet (Fig. 26). This measures on an average 95 degrees.
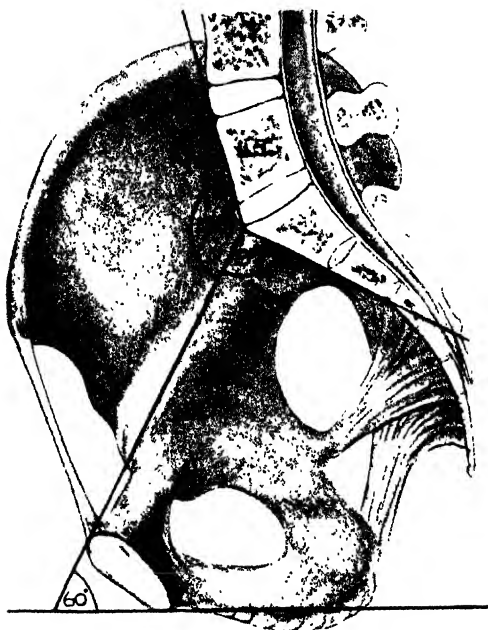
FIG. 26.

The angle of inclination of the pelvic brim is 135 degrees. The inclination of the sacrum is 95 degrees. The inclination of the pelvic brim to the horizontal is 60 degrees.

Average dimensions of the normal pelvis

It must be clearly understood that the pelvic diameters vary just as much as patients' heights vary, and that the diameters will also be affected by the pelvic shape. What matters during delivery is not the absolute size of the pelvic cavity but the size relative to that of the fœtal head. However, in a woman of average height with a normal pelvis the following measurements are to be expected.

Diameter of the brim. The antero-posterior diameter of the brim (or true conjugate) is measured from the back of the upper part of the symphysis pubis to the promontory of the sacrum, and measures 10·8 cm. (4¼ inches).

The transverse diameter of the brim is the widest transverse measurement at this level, and measures 13·3 cm. (5¼ inches). (See Fig. 27a.)

Diameters of the pelvic cavity. The plane of the cavity has already been defined (p. 76). The antero-posterior diameter extends from the back of the middle part of the symphysis pubis to the middle piece of the sacrum, and measures 12 cm. (4¾ inches).

The transverse diameter of the cavity is the widest transverse diameter at this level, and also measures 12 cm. (4¾ inches).

Diameter of the pelvic outlet. It will be observed that the ischial tuberosities project downwards well below the plane of the pelvic outlet (defined on p. 76) and the long boundaries of the outlet do not occupy a simple plane like those of the brim. (See Fig. 27b.)

The antero-posterior diameter of the outlet is measured from the lower part of the symphysis pubis to the end of the sacrum (*not* the coccyx, which is mobile), and measures 13·3 cm. (5¼ inches).

The transverse diameter is measured between the inner surfaces of the ischial tuberosities, and measures 10·8 cm. (4¼ inches). (See Fig. 27c).

SUMMARY OF PELVIC MEASUREMENTS

The average normal measurements may be summarized thus:

	Antero-posterior	*Transverse*
Brim	10·8 cm. (4¼ inches)	13·3 cm. (5¼ inches)
Cavity	12·0 cm. (4¾ inches)	12·0 cm. (4¾ inches)
Outlet	13·3 cm. (5¼ inches)	10·8 cm. (4¼ inches)

It will be seen that the brim is a transverse oval, the cavity is round, and the outlet is an antero-posterior oval.

It is possible to describe oblique diameters of brim, cavity and outlet, but these measurements have no practical value.

Clinical examinations of the pelvis

A pelvic examination is usually undertaken early in pregnancy, to confirm the diagnosis, to exclude abnormalities of the pelvic organs, and to assess the capacity of the bony pelvis. If the patient has miscarried previously, or has had a threatened miscarriage, it is wise to postpone any internal examination until the 16th week of pregnancy or even later, and a further pelvic examination is often necessary about the 36th week of pregnancy in cases of suspected disproportion. It must not be forgotten that the fœtal head is the best pelvimeter.

In this chapter we are concerned only with the clinical assessment of the bony pelvis.
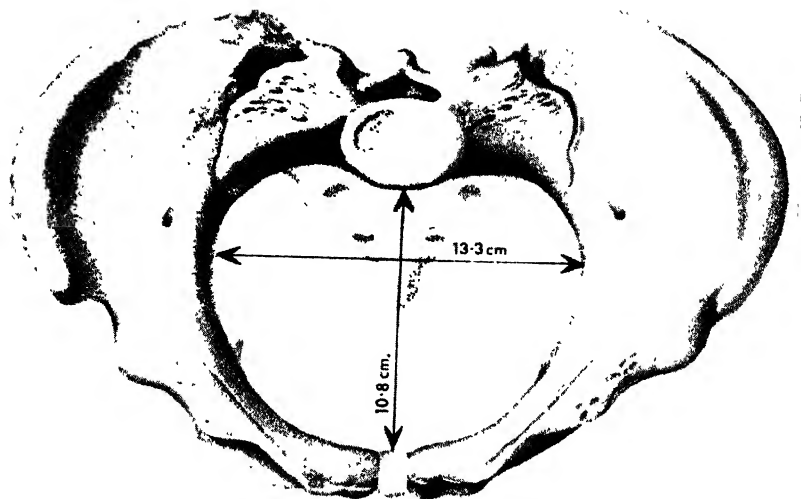
FIG. 27a.
The pelvic brim
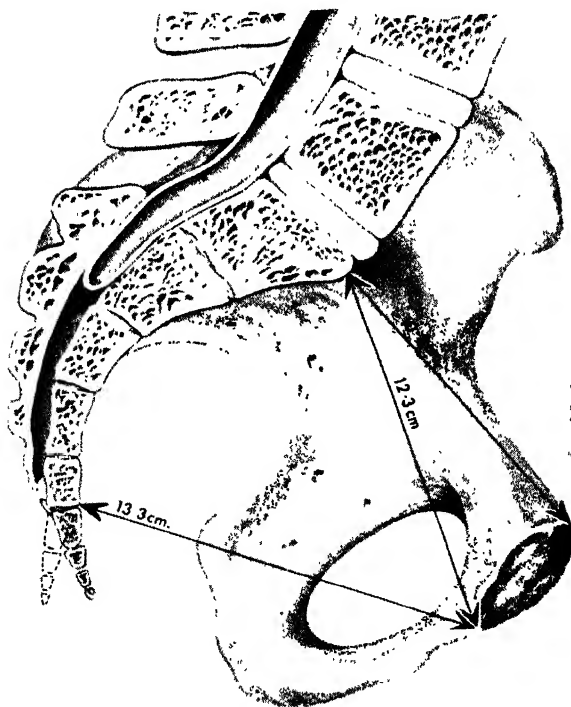
FIG. 27b.
Saggital section of pelvis. The true and diagonal conjugate diameter.
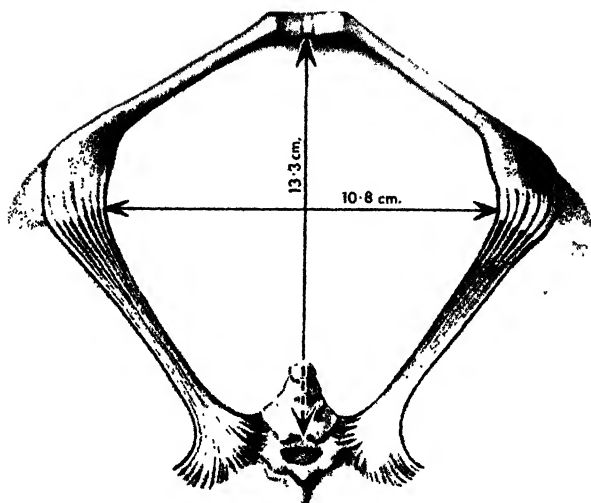
FIG. 27C.
Pelvic outlet.

External pelvimetry

It was formerly the practice to use large metal calipers to measure the distance between various external bony points on the pelvis, for example the distance between the most lateral parts of the iliac crests (intercristal diameter) or the distance between the tip of the spine of the last lumbar vertebra and the symphysis pubis (external conjugate).

It is now generally recognized that the external pelvic messurements cannot give an accurate picture of the shape or size of the true pelvis, and the practice of taking them has been abandoned in nearly all obstetric units.

The sub-pubic angle between the descending pubic rami may be palpated with the thumbs of both hands pressed against the pubic rami but a much better method is by palpation of the deep aspect of the arch from the vagina. The angle normally measures slightly more than a right angle.

Measurements with a tape measure may be useful in cases of suspected pelvic obliquity. Tilting of the pelvis will be confirmed by measuring from the anterior superior iliac spine to the internal malleolus on each side. Tilting of the pelvis is only accompanied by asymmetry if the causative disease or injury occurred in early life. Tape measurements from the fifth lumbar spine to the symphysis, taken on each side, will suggest true pelvic obliquity if they are unequal.

Internal pelvimetry

Assessment of the diameters of the brim. The diagonal conjugate is the distance between the promontory of the sacrum and the lower margin of the symphysis pubis. The sacral promontory cannot be felt in a normal pelvis unless the patient is anæsthetized. If it can be reached by the examining finger it is reasonable to conclude that the true conjugate diameter is considerably shorter than normal, and the case should be treated as one of potential disproportion. The true conjugate measures 1·3 cm. ($\frac{1}{2}$ inch) less than the diagonal conjugate (see Fig. 27b).

Assessement of the pelvic cavity is also undertaken by vaginal examination and is of much greater clinical value than external pelvimetry. A general idea of the capacity of the true pelvis can be formed and outstanding abnormalities noted. The anterior surface of the sacrum should be palpated from above downwards. In some cases the concavity is marked, and the lower part of the sacrum and coccyx may project forwards very considerably; in other cases the upper part of the sacrum may be straight or even slightly convex. The antero-posterior diameter of the cavity is the distance between the junction of the second and third sacral segments and the middle of the posterior surface of the symphysis, but it may be assessed clinically by measuring to the lower border of the symphysis as described for the diagonal conjugate.

Assessment of the lower pelvic strait. Measurement of the distance between the ischial tuberosities should only be taken as a rough estimate of the pelvic outlet, and a further assessment of the lower pelvic strait should always be undertaken by vaginal examination.

The distance between the ischial spines, normally 10 cm. (4 inches), is difficult to measure clinically with any accuracy. The ischial spines should be found by sweeping a finger down the curve of the sacrosciatic notch on each side, and with experience an impression may be formed as to whether the inter-ischial spinous diameter is normal or not.

The antero-posterior diameter of the outlet is measured from the sacro-coccygeal joint to the lower border of the symphysis pubis, as described for measurement of the diagonal conjugate, and the mobility of the coccyx should also be noted. If it is fixed this measurement should be taken from the tip of the coccyx. The antero-posterior diameter of the outlet normally measures 13·3 cm. or 5$\frac{1}{4}$ inches, but the antero-posterior diameter available for the fœtal head to emerge will be lessened if the sub-pubic arch is narrow.

X-ray pelvimetry

Various radiological techniques have been developed accurately to determine the measurements of the internal pelvic diameters and the measurements of the fœtal skull. These are described in detail on

ANATOMY OF THE FŒTAL SKULL

A THOROUGH knowledge of the anatomy of the fœtal skull is necessary before the mechanism of labour can be understood, for the size, shape and consistency of the skull all play a part in the mechanism of both normal and abnormal labour.

The fœtal skull may be divided into the vault, face, and base. Calcification during intra-uterine life takes place more completely in the bones of the face and base than in the vault, and at birth they are firmly united to each other. The bones comprising the vault of the skull, however, are not so ossified, and when the child is born they are united only by thin unossified membranes. The result of this difference in development is that, while the bones of the base and face are incompressible, and so prevent damage to the vital centres in the medulla, which they surround, the vault is compressible, and thus allows of the size of the skull being diminished, and the shape altered, during its passage through the pelvis, by which means its expulsion is made much easier. This diminution in size is due to the fact that, by compression, the cerebro-spinal fluid and blood in the fœtal brain are distributed to other parts of the body, while the change in shape, or moulding as it is termed, is brought about by the pliability of the bones of the vault and the presence of the membranes uniting them, which allow one bone to overlap the other. During the passage of the head, in a left occipito-anterior presentation for instance, the parietal bones overlap the frontal, occipital and temporal bones, and the right parietal overlaps the left parietal bone.

Vault of the fœtal skull

The vault of the fœtal skull consists of certain bones, sutures, and fontanelles.

Bones. The bones of the fœtal skull, which form the vault, are the two parietal and certain portions of the occipital, frontal, and temporal bones. At birth the frontal bone is divided into two equal parts.

Sutures. The unossified membranes which unite the various bones of the vault are known as sutures. There are six of these sutures.

1. The sagittal suture, uniting the superior borders of the parietal bones.
2. The frontal suture, which is a continuation of the sagittal suture, uniting the two portions of the frontal bone.
3. The lambdoidal suture, uniting the posterior borders of the two parietal bones to the occipital bone.

Anterior
fontanelle
or bregma.

Coronal
suture.

Frontal
suture.

Glabella.

FIG. 28.   The fœtal skull.

Posterior
fontanelle.

Parietal
bone.

Sagittal
suture.

Anterior
fontanelle
or bregma.

Coronal
suture.

Frontal
bone.
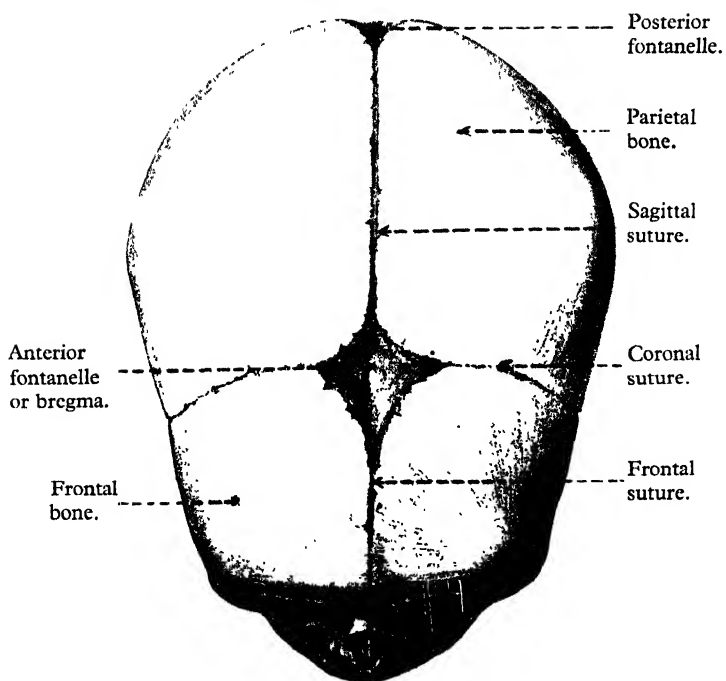
Frontal
suture.

FIG. 29.   The fœtal skull.

4. The coronal suture, uniting the anterior borders of the parietal bones to the frontal bones.

5 and 6. The temporal sutures, uniting the squamous portion of the temporal bones to the inferior borders of the parietal bones.

Vertex

Parietal bone.

Head of arrow at parietal eminence.

Posterior fontanelle.

Posterior temporal fontanelle.

Occipital bone.

Anterior fontanelle or bregma.

Frontal bone.

Coronal suture.

Anterior temporal fontanelle.

Temporal suture.

Temporal bone.

Mastoid process.
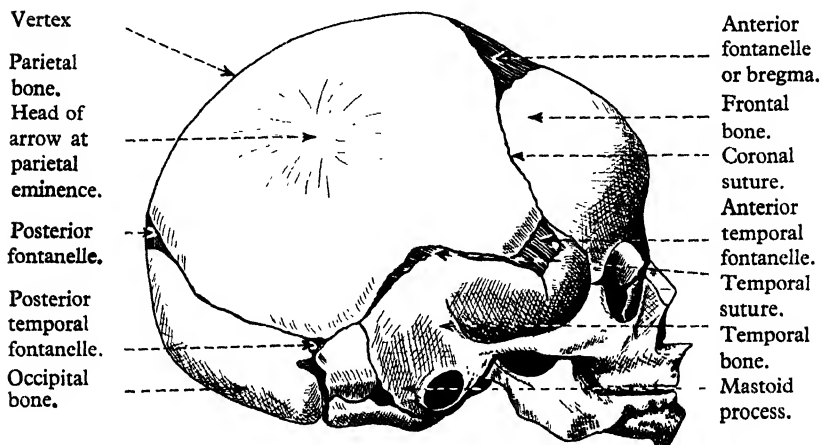
FIG. 30.   The fœtal skull.

Fontanelles. The points of junction of the various sutures are termed fontanelles, and they are six in number.

1. The anterior fontanelle, where the sagittal, frontal, and coronal sutures meet.

2. The posterior fontanelle, where the sagittal and lambdoidal sutures meet.

3 and 4. The anterior temporal fontanelles, at the junction of the temporal and coronal sutures.

5 and 6. The posterior temporal fontanelles, at the junction of the temporal and lambdoidal sutures.

Only the anterior and posterior fontanelles are of obstetrical importance. Their position when felt on vaginal examination indicates in which direction the occiput is pointing and the amount of flexion or extension present.

The anterior fontanelle or bregma can easily be felt unless obscured by a large caput succedaneum. It is much the larger of the two, is roughly lozenge-shaped, has four sutures running into it, is always patent at birth, and takes about 20 months to close. The posterior fontanelle is triangular in shape, has three sutures running into it, in most cases cannot be felt as a space during labour, and closes soon after. The temporal fontanelles cannot be felt and are not, therefore, of assistance in diagnosing the position of the head.

DIAMETERS OF THE FŒTAL SKULL

The principal diameters of the skull concerned in the mechanism of labour may be divided into longitudinal, vertical and transverse.

Longitudinal diameters

Mento-vertical. From the point of the chin to the farthest point on the vertex, which is nearer the posterior than the anterior fontanelle, 13·3 cm.
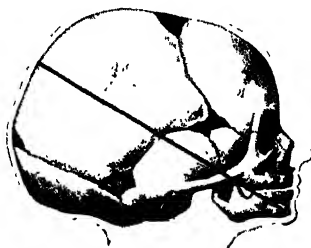
FIG. 31.

Mento-vertical diameter, 5¼ inches (13·1 centimetres).

FIG. 32.

Showing the diameter, Fig. 31, thrown across the pelvis in a brow presentation.

(5¼ inches) (Fig. 31). This is the diameter thrown across the pelvis in a brow presentation, the head being midway between flexion and extension (Fig. 32).

Occipito-frontal. From the root of the nose (glabella) to the posterior fontanelle, 11·4 cm. (4½ inches) (Fig. 33). This is the diameter thrown across the pelvis in a persistent occipito-posterior position and in incomplete flexion of the after-coming head (Figs. 34 and 35).
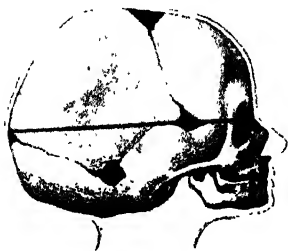
FIG. 33.

Occipito-frontal diameter, 11·4 cm. (4½ inches).

FIG. 34.   FIG. 35.

Showing the diameter, Fig. 33, thrown across the pelvis in a persistent occipito-posterior position, and in incomplete flexion of the after-coming head.

Vertical diameters

Suboccipito-bregmatic. From the junction of the head with the neck behind to the centre of the anterior fontanelle, 9·5 cm. (3¾ inches) (Fig. 36). This is the diameter thrown across the pelvis when the head is completely flexed (Fig. 37).

Suboccipito-frontal. From the junction of the head with the neck behind to the prominence of the forehead, 10·2 cm. (4 inches). This is the diameter thrown across the pelvis when the head is not completely flexed and is the diameter which has to pass through the vulva at the moment of normal delivery (Fig. 38).
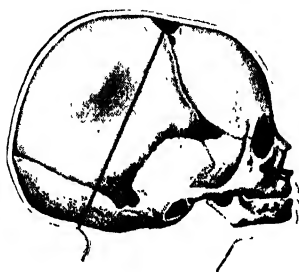
FIG. 36.

Suboccipito-bregmatic diameter,
9·5 cm. (3¾ inches).
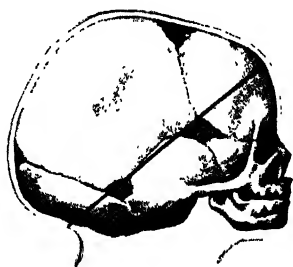
FIG. 38.

Suboccipito-frontal diameter,
10·2 cm. (4 inches).
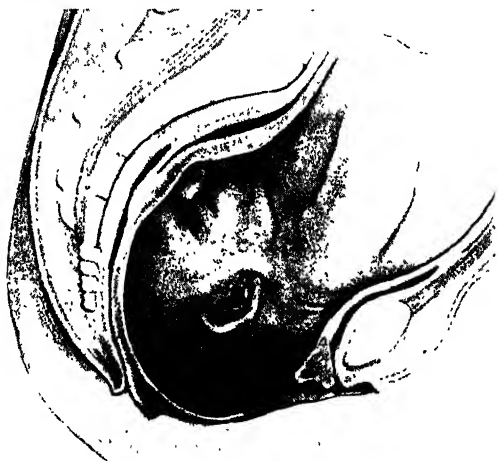
FIG. 37.

Showing the diameter, Fig. 36, thrown across the pelvis when the head is completely flexed. When the head is not quite so well flexed the suboccipito-frontal diameter, Fig. 38, 10·2 cm. (4 inches), is thrown across the pelvis and distends the vulval orifice during the birth of a normal vertex.

Submento-bregmatic. From the junction of the head with the neck in front to the middle of the anterior fontanelle (bregma), 9·5 cm. (3¾ inches) (Fig. 39). This is the diameter thrown across the pelvis when the face is presenting with full extension of the head (Fig. 40).
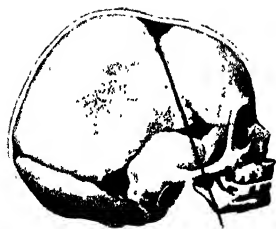
FIG. 39.

Submento-bregmatic diameter,
9·5 cm. (3¾ inches).

FIG. 40.

Showing the diameter, Fig. 39, thrown
across the pelvis in a face presentation
with the head completely extended.
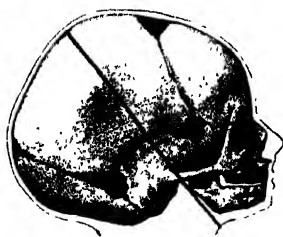
FIG. 41.

Submento-vertical diameter
11·4 cm 4½ inches)

FIG. 42.

Showing the diameter, Fig. 41, thrown
across the pelvis when the face is
presenting and the head is not fully
extended.

Submento-vertical. From the junction of the head, with the neck (Fig. 41) in front, to the farthest point on the vertex, 11·4 cm. (4½ inches). This is the diameter thrown across the pelvis when the face is presenting and the head is not fully extended (Fig. 42); it also distends the vulva at the moment of delivery.
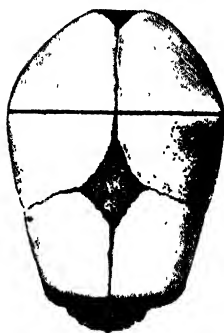
FIG 43.

Bi-parietal diameter, 9·5 cm. (3¾ inches).

FIG. 44.

Showing the largest diameter entering the transverse diameter of the brim in a flattened pelvis.

Transverse diameters

Bi-parietal. From one parietal eminence to the other, 9·5 cm. (3¾ inches) (Fig. 43). This is the largest diameter entering the antero-posterior diameter of the brim in a flattened pelvis (Fig. 44).

FIG. 45.

Bi-mastoid diameter, 7·6 cm. (3 inches). The incompressible base. As it is impossible to reduce the length of the bi-mastoid diameter by an obstetrical operation, a flattened pelvis must have one diameter at the brim at least 7·6 cm. (3 inches) long, or a generally contracted pelvis must not have any diameter smaller than this, even to enable the crushed head to be extracted at craniotomy.

Bi-temporal. From the points farthest apart on the coronal sutures, 8·3 cm. (3¼ inches).

Bi-mastoid. From the points farthest apart on the mastoid processes of the temporal bone, 7·6 cm. (3 inches) (Fig. 45).

Superparieto-subparietal. From above one parietal eminence to below the other, 8·9 cm. (3½ inches). (Fig. 46). This is the transverse diameter which engages in the pelvis owing to the lateral tilting of the head in flattened pelves (Naegele's obliquity) (see p. 412 and Fig. 47).

Circumference of the fœtal head. The smallest circumference of the fœtal head is that taken in the plane of the suboccipito-bregmatic diameter. It measures 29 cm. (11½ inches). A somewhat larger circumference is that
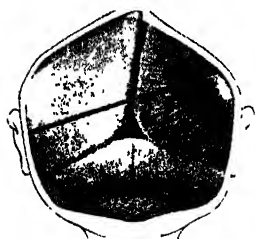
FIG. 46.
Superparieto-subparietal
diameter, 8·7 cm. (3½
inches).

FIG. 47.
Showing the transverse diameter, FIG. 46, which engages in the flattened pelvis owing to the lateral flexion of the head (Naegele obliquity).

taken in the plane of the suboccipito-frontal diameter, the circumference which commonly distends the vulval orifice in normal labour. The largest is that taken in the plane of the vertico-mental diameter. It measures 38 cm. (15 inches).

The circumference of the fœtal head taken in the plane of the occipito-frontal diameter, measures 34 cm. (13½ inches). This is the circumference that distends the vulval outlet in the birth of a persistent occipito-posterior position.

The heads of males are, on the average, rather larger than those of females, and the size of the skull and the degree of its ossification often increase with successive pregnancies.

The great folds of dura mater, the falx cerebri and tentorium cerebelli, from their position and attachments, act in some degree as internal ligaments, resisting too great deformity of the plastic fœtal head both in the

longitudinal, transverse and oblique directions. If moulding is very excessive, or if the fœtal head is subjected to severe and sudden stresses, these portions of dura mater are liable to be torn. Some of the great venous sinuses are then in great danger of rupture also. These are the inferior longitudinal sinus, running in the free edge of the falx cerebri and receiving posteriorly the veins of Galen from the brain, and the straight sinus running between the falx cerebri and tentorium cerebelli.

Post-mortem examinations of fœtuses still-born or born in white asphyxia after difficult labour, often disclose tears of these folds of dura mater.

DIAMETERS OF THE FŒTAL TRUNK

Bis-acromial. Between the points farthest apart on the shoulders, 12·1 cm. ($4\frac{3}{4}$ inches).

Bi-trochanteric. Between the points farthest apart on the great trochanters, 10·2 cm. (4 inches).

ANTENATAL CARE

ANTENATAL investigation is to be regarded as a part of preventive medicine, its object being to maintain the mother in health of body and mind, to preserve her pregnancy to term, to avoid difficulty and complication in labour, to ensure the birth of a living and healthy infant, and to help the mother to rear the child.

It is the duty, therefore, of a medical practitioner, on being asked to undertake a confinement case, to point out the necessity of examining his patient and of keeping her under supervision prior to the actual labour in the interest both of the mother and the child.

The number of times a patient should be seen to ensure adequate antenatal care may vary a little, but in an uncomplicated case the following may be considered as the minimal number desirable.

The first visit when the patient comes to make arrangements should be as early as possible, and at this time a full history should be taken and a general examination made. Thereafter the patient should be seen every 4 weeks until the 32nd week, every 2 weeks until the 36th week, and then every week until the onset of labour. If any complications arise, more frequent visits may be necessary.

At each visit the general health of the patient is noted, the blood-pressure should be taken, the urine tested and the weight noted. Every 4 weeks the abdomen should be examined and the increase in the size of the uterus observed. After the 24th week the fœtal heart may be heard, and by the 28th week the presentation of the fœtus may be felt. From the 32nd week onwards the presentation of the fœtus should be carefully determined so that any malpresentation may be corrected. At the 36th week the most important observation is whether the fœtal head will engage in the pelvis.

If the onset of labour is delayed beyond the expected date of delivery a further abdominal examination should be made to observe whether the fœtus appears to be getting too large for the pelvis.

Details of vaginal examinations will be given later.

The investigation should be carried out in a systematic manner. In the first place the history of the patient should be taken. It is important to know whether she has had scarlet fever, rheumatic fever, rubella, chorea, chronic renal disease or a blood-transfusion.

If she has been pregnant before, she should next be questioned with regard to the details of former pregnancies and labours, for these may provide information of the greatest value. For example, a history of

repeated abortions or repeated premature labours, especially with dead or macerated fœtuses, will suggest syphilis, chronic renal disease or possibly rhesus incompatibility. A history of albuminuria, œdema, and convulsions will indicate previous toxæmia of pregnancy, and therefore the need for more careful supervision.

The obstetric history of previous labours is the most important guide as to what is to be expected at subsequent labours. If the patient has had a long labour requiring anæsthesia and instrumental delivery, resulting possibly in the birth of a dead or injured child, or one which has died shortly after birth from intracranial damage, it is possible that the mother has some pelvic contraction or bony deformity. A history of repeated malpresentations in previous pregnancies and labours might also suggest the same condition.

It is of great value to know the birth-weight of the patient's previous children. The circumference of the fœtal head taken immediately after birth, before the moulding has had time to alter, is an indication of the amount of space in the pelvis and the shape of the bony birth canal, but such information is rarely obtainable.

It is important also to know whether the children were breast or bottle fed, whether they survived, and the cause of death in any who died subsequently. If the patient has been unable after previous labours to nurse her children, or has been able to do so for only a short time, it is often possible in such cases by special attention to ensure the breast-feeding of her infant. If the previous children have died as a result of diarrhœa and vomiting, this may be avoided on a subsequent occasion by educating the mother in the care of her infant, and by the supervision of her management of the child after labour.

The history of the present pregnancy should then be taken. A note should be made of the patient's normal menstrual cycle and the date of her last regular period and of any abnormal symptoms.

The general examination is then made. The height and development are noted together with the gait and any deformity. The heart and lungs are examined for evidence of disease, and cyanosis or breathlessness are noted. In some clinics a routine X-ray examination of the chest is made and this practice has much to commend it. The thyroid is palpated for signs of enlargement, and the eyelids, hands, and ankles are investigated for evidence of œdema. The blood-pressure, systolic and diastolic, is estimated, and the urine is examined, particularly for albumin, casts, pus and sugar. On the patient's first visit, a sample of blood is taken and sent for examination to discover whether she is rhesus positive or negative, the blood-group should be determined and a blood-count and Wassermann reaction done. The patient should be weighed at each visit, an undue increase of weight being regarded as evidence of impending toxæmia.

Dental caries may progress during pregnancy and the teeth should therefore be inspected and, if necessary, thoroughly overhauled. Not only is this of importance with regard to the maintenance of general health, but also because septic teeth or gums may form the focus for subsequent infection. The tonsils and fauces also need examination since chronic infection of either of them is accompanied by the same danger.

After examining the breasts (see p. 49) an examination of the abdomen should be undertaken. Full details of this are given in the chapter on obstetric diagnosis. (See p. 108.)

In most clinics a vaginal examination is made at the patient's first visit. At this examination the early enlargement of the uterus can be noted and its position, anteverted or retroverted, determined. The important thing here is to look for any abnormal swellings such as an ovarian cyst or a fibroid. Some idea of the general shape of the pelvis may be made, but efforts to measure the pelvis are perhaps better postponed until later in pregnancy. This second vaginal examination to measure the pelvis and estimate its shape may conveniently be made at about the 36th week, when the tissues are more relaxed and the risk of disturbing the pregnancy is very slight. (For details see p. 111.)

At the end of the patient's first visit she should be told to attend once a month, when the height of the fundus should be recorded, the urine tested and the blood-pressure estimated. At each visit from the 32nd to the 36th weeks the presentation of the fœtus should be made out, as this is the best time to correct a malpresentation if found. (See p. 370.)

At the 36th week the most important observation is to determine whether the largest diameter of the head has passed the brim of the pelvis, or, if it is still above the brim, whether it can be pressed in. If there is any doubt about this it suggests that there may be some disproportion between the size of the fœtal skull, and the pelvis. This will be considered in further detail later.

The patient should be advised to notify her doctor at once should any of the following symptoms arise: persistent headache; disturbance of vision; swelling of the face or ankles; bleeding.

During pregnancy the patient should be advised to attend the instruction classes which are now generally available at antenatal clinics. (See p. 98.)

Diet. During pregnancy there is no need for any appreciable increase in the calorie value of the patient's diet; but the distribution of its constituents requires alteration. The protein and the mineral salts should be increased to supply the needs of the fœtus. The fats should remain adequate to ensure sufficient intake of calcium and vitamins A and D, and the carbohydrates should be reduced a little to keep the total intake to a reasonable level, and prevent excessive gain of weight.

During pregnancy a careful check should be kept on the patient's weight. Providing it is within normal limits at the outset, the increase should not exceed 28 pounds during the pregnancy. There is very little, if any, increase during the first 12 weeks; after this the increase should be at the rate of about 4 pounds every 4 weeks. If it exceeds 5 pounds during that period, in the absence of any evidence of toxæmia, it must be considered excessive and carbohydrates should be reduced.

A number of very interesting investigations on the effects of diet on the outcome of pregnancy have been made. It has been shown that a poor quality diet predisposes to premature labour and stillbirth (Aberdeen). A poor quality diet too has been shown to increase the incidence of toxæmia (Toronto). Another investigation showed that the addition of iron and vitamins to a poor diet reduced the risk of both premature labour and toxæmia. Claims that pre-eclamptic toxæmia can be eliminated or reduced in incidence by modification of the diet during pregnancy have not been substantiated.

All the evidence, therefore, emphasizes the importance of a carefully balanced diet during pregnancy. Protein should be increased and at least two-thirds of the protein should be of animal origin, i.e. meat, milk, eggs, cheese and fish.

Fats. The intake of fats should be adequate: it will be, if sufficient milk, cheese, eggs and meat are taken. Extra fat is unnecessary. Carbohydrates should be reduced slightly to compensate for the increased calorie value of the protein intake.

Mineral salts. In the latter half of pregnancy there is a need for a considerable increase in the intake of calcium, phosphorus and iron, and probably other trace elements to supply the needs of the growing fœtus, and to prepare the mother for lactation. Milk, cheese, eggs, meat and fresh green vegetables are foods rich in mineral salts, and a well balanced diet will contain sufficient minerals. The average adult diet in this country is, however, barely sufficient so that unless special care is taken by the patient, it may be necessary to increase the intake of calcium.

Calcium. The amount of calcium required daily by an adult is 0·5 g.; during pregnancy and lactation the amount is increased to 1·5 g. It is contained in milk, cheese, some vegetables and bread. It is difficult to be sure that all the calcium taken is absorbed; for example, the phytic acid of bread flour produces an insoluble salt of calcium. Again vitamin D is necessary for the absorption of calcium, so that it is desirable that every pregnant woman should take a calcium preparation containing vitamin D. A daily dose equivalent to 30 gr. of calcium lactate is sufficient.

Iron. Many women start pregnancy with a slight degree of anæmia, so that it is always wise to check the hæmoglobin level throughout pregnancy and give iron medicinally as required, and prophylactically to

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supply the increased requirement. The preparation most commonly used is ferrous sulphate, 200 to 300 mg. (3 to 5 gr.) three times a day after meals. This preparation may cause slight irritation of the gastric mucosa in a few patients, and such patients may tolerate ferrous gluconate, 300 mg. (5 gr.), better. (See Anæmia, p. 262.)

Folic acid. During pregnancy anæmia due to deficiency of folic acid may occur (see p. 265) and in many clinics the patients are now given folic acid 5 to 10 mg. daily during the second half of pregnancy.

Exercise. The natural tendency for a pregnant woman is to rest more than usual, particularly as full time is approaching. This desire must be combated up to a point since it is essential that the patient should have plenty of fresh air and walking exercise daily, not only to keep her in health during her pregnancy, but also to fit her for the increased muscular efforts which will attend her labour. Light housework is quite harmless. All exercise of a violent nature, however, should be avoided on account of the risk of miscarriage.

Education of the expectant mother. It is obvious from what has been said about diet that the young mother will benefit from some instruction and in most clinics classes are arranged for this purpose. There are many other subjects on which instruction may be useful, such as the preparation of the baby's clothes and the advantages of breast feeding. It is important that the patient's anxiety about labour should be allayed, for fear undoubtedly plays some part in delaying the process. A simple explanation of the stages of labour should therefore be given to the patient so that she may know what to expect. This too is a convenient time to demonstrate the use of the gas and air or trilene apparatus for analgesia. It is also helpful if the ward sister can meet the patient so that when she arrives in labour she finds herself amongst friends.

In many clinics patients are given a course of instruction in antenatal exercises. These exercises are directed more to the patients' posture and general physique than to the muscles specially concerned with childbirth. Many patients benefit from instruction in the relaxation of muscle tone, so that they may be able to relax voluntarily during the uterine contractions of the first stage of labour. This end may also be attained by deep breathing during pains. This is the basis of the method of 'psycho-prophylaxis'.

If this programme is carefully carried out, the majority of patients will be physically fit at the onset of labour and may approach the confinement with less apprehension.

Regulation of the bowels. Constipation is a troublesome complication in most pregnant women. Strong purgatives must be avoided since they

are liable to cause miscarriage. If by attention to the diet, which should include plenty of vegetables and fresh fruit, a proper and daily evacuation of the bowels can be ensured, well and good; otherwise mild aperients, such as cascara or senna may be prescribed. Liquid paraffin may also be usefully prescribed.

Treatment of the nipples. This is discussed on page 163.

Examination of the urine. The urine of a pregnant woman should be examined for albumin and sugar at least once a month till the 32nd week, once a fortnight till the 36th week and then weekly till labour starts. It is only by repeated examination of the urine that the first indications of pre-eclampsia can be detected, and many women have lost their lives owing to the neglect of this simple precaution. Diabetes may also be discovered for the first time during pregnancy (see p. 274). The patient should be warned to report, without delay, a marked diminution in the amount of urine passed because this may be a sign of pre-eclampsia.

Estimation of blood-pressure. Blood-pressure readings, systolic and diastolic, should be made with the same frequency as examination of the urine. In the early stages of toxæmia, a rise of blood-pressure will usually be observed before albuminuria. The blood-pressure is generally considered to be raised if the systolic reading is above 140 mm. Hg and the diastolic above 80 mm. Hg.

Nervous system. Sleeplessness, which is at times a somewhat troublesome complication, may be treated, if severe enough, with hypnotics such as butobarbitone 200 mg. (3 gr.), or dichlorphenazone (Welldorm) 2 G. (30 gr.).

Coitus. Inquiries are not uncommonly made as to the advisability of coitus during pregnancy. It is generally considered that coitus increases the risk of miscarriage during the first 12 weeks, and must be avoided during the last month to prevent infection.

Corsets. These will seldom be necessary in a healthy woman with good abdominal muscles, but she should be advised to wear a suspender belt to support her stockings and not wear garters which will accentuate the tendency to varicose veins. In multiparæ, if the abdomen is pendulous, a properly fitting corset should be advised. Support of the breasts by a brassiere is often necessary, but it should not be tight and pressure on the nipples should be avoided.

Minor disorders of pregnancy

Morning sickness. From the 6th to about the 14th week nausea or vomiting in the early morning is so common that it is described as one of the symptoms of pregnancy. It is most marked soon after waking and is generally retching rather than vomiting. The condition is self-limited and tends to disappear before the 16th week. For treatment see page 215. If the patient vomits frequently after her meals, this is abnormal and is considered further on page 211.

Ptyalorrhœa. An apparent increase in the amount of saliva occasionally occurs during pregnancy and it may prove a most distressing complication. The patient spits out her saliva instead of swallowing it and lives in an aura of wet handkerchiefs. The complaint occurs, as a rule, during the early part of pregnancy, and coincides in time with the period of morning vomiting. There is a tendency for the symptom to recur in succeeding pregnancies. The effects upon the patient are distressing, not only because of the unpleasantness of the symptom, but because she is so constantly disturbed. There may be an accompanying rapid loss of weight from the loss of body fluid.

Treatment is unsatisfactory. Psychological factors should be borne in mind and treated as such.

Varicose veins. Varicose veins of the lower limbs or the vulva may cause considerable distress during pregnancy, and serious hæmorrhage may arise from the latter during labour. In the legs and ankles varicosity may be associated with œdema, varicose eczema, ulceration, and with thrombosis. Fortunately pulmonary embolism from such thrombi is extremely rare. Rest, and support by means of elastic stockings, or elastoplast in case of ulceration, afford relief.

Surgical treatment during pregnancy is not generally advised because the condition often improves very much after the baby is born. The residual lesion should be assessed six months after delivery with a view to surgical treatment.

Hæmorrhoids. Hæmorrhoids are not infrequent sources of pain and of hæmorrhage during pregnancy. Surgical procedures are contra-indicated except for evacuation of a painful perianal hæmatoma under local anæsthesia. Suitable aperients should be prescribed; the anal region should be carefully cleansed and dried after each evacuation of the bowels, and astringent analgesic ointments applied, such as hamamelis ointment.

Acroparæsthesia. See p. 289.

Cramps in the legs. Transient nocturnal painful spasm of the small muscles of the feet, or of the muscles of the legs, sometimes occurs during pregnancy. Such cramps have been attributed to deficiency of calcium (and have often been treated by giving calcium gluconate) but there is no satisfactory evidence to support this theory. It is more likely that they are due to temporary circulatory changes in the legs.

Pruritus vulvæ and vaginal discharge. Any excess of vaginal discharge may cause some irritation of the vulva. Early in pregnancy a gonococcal infection may be responsible, but far the commonest cause in the later months is a monilial infection of the vagina which is associated with the increased tendency to glycosuria which is seen during pregnancy. In a few cases a local cause cannot be found to account for the itching, which is not always confined to the vulva.

In all cases of pruritus the urine should be tested for sugar, and if there is any reason to suspect that the patient has diabetes, the blood-sugar should be estimated. A smear from the vagina should be examined microscopically and cultured, and this may show monilial threads. Inspection of the vaginal walls may show the typical appearance of a monilial infection, a general redness of the vagina with numerous plaques of cheesy material lightly adherent to the vaginal epithelium being seen.

Monilial infections are difficult to eradicate during pregnancy although they nearly always clear up quickly after delivery. It is generally necessary to reduce the carbohydrate intake and so reduce the amount of sugar in the urine. Local treatment consists of carefully cleaning the vagina till all the monilial deposits have been removed, and then painting of the vagina with a one per cent aqueous solution of gentian violet. It may be necessary to repeat this treatment every 3 days for several weeks.

An alternative method of treatment is by the antibiotic nystatin. The patient should be instructed to insert a vaginal tablet containing nystatin each morning and evening for 7 to 10 days. This method is generally very successful but may have to be repeated in some cases as recurrent infection is not uncommon.

Trichomonal infection of the vagina may occur during pregnancy. Metronidazole (Flagyl) tablets, 200 mg. three times daily by mouth for 10 days, may be used in late pregnancy. Although no adverse effect on the foetus has ever been shown to occur with this drug, it may be wiser to rely on local treatment before the 16th week, using acetarsol pessaries, one or two inserted vaginally nightly for 21 days.

Herpes gestationis. This skin disease is probably a variant of dermatitis herpetiformis. It tends to recur in the same patient in successive pregnancies. The eruption usually appears during the second half of pregnancy.

The patient complains of itching and burning which at times become intolerable. The rash at first appears on the trunk and legs, and may eventually affect other parts of the body. It assumes a multiform character; erythematous patches, vesicles, and bullæ appearing indiscriminately. Herpes gestationis has no effect on the pregnancy, but the sleeplessness arising from the irritation may cause the woman to become exhausted.

Locally bismuth and starch powder or phenol lotion may be applied. Cortisone has been recommended.

HARMFUL EFFECTS OF DRUGS ON THE FŒTUS DURING PREGNANCY

Following the discovery that the sedative drug thalidomide given to women in early pregnancy could cause gross deformities of the fœtal limbs, all drugs used in pregnancy came under scrutiny for their possible teratogenic effects. It seems inevitable that a certain proportion of pregnancies will result in a fœtus suffering from congenital defects. Figures show that the incidence of serious malformation is slightly more than 2 per cent of births, and half of these children do not survive until the age of five years. The majority of these malformations occur as the result of genetic or environmental disturbances that are unrelated to the drugs which the mother may have taken during her pregnancy. It is an important principle of teratology that it is not so much the nature of a harmful influence on the developing fœtus as the time in embryonic development at which it acts that determines the extent and particular type of abnormality produced. In general, the earlier in pregnancy that teratogenic agent acts the more severe the fœtal malformation. There is, furthermore, a short critical period during which each developing structure in the body is particularly vulnerable. For a drug to cause a fœtal malformation it has to be relatively harmless to the mother but not so harmful to the fœtus as to kill it. There seem to be many factors in the mother which determine the teratogenic effect of a drug such as the age, parity, standard of nutrition and hormone levels. The following is a brief account of what we know about the possible teratogenic and other harmful effects of drugs that are commonly used in pregnancy.

Thalidomide

This drug is an effective sedative and anti-emetic. By 1962, when it was withdrawn from the market, nearly 500 deformed children had been born in England and Wales to mothers who had taken thalidomide in early pregnancy. About half of these children survived. The main deformities were of the limbs including amelia (absence of limbs), phocomelia (the proximal part of the limb is missing), and hemimelia (the distal part of the limb is missing). Many of the babies had other limb malformations and

also abnormalities of the eye, ear, and heart and of the intestinal, genito-urinary and genital tracts. The critical time in pregnancy during which the effects were produced was from the 30th to the 70th days.

This experience with thalidomide led to a critical awareness of the possible dangers of the use of drugs in pregnancy. The Ministries of Health in Great Britain have, furthermore, set up an expert Committee on the Safety of Drugs under the chairmanship of Sir Derrick Dunlop to study toxicity tests and to supervise clinical trials before advising whether or not a drug might be released for marketing. The Committee demands that adequate tests are carried out on pregnant animals before a drug is used in women. A scheme has also been introduced in England and Wales for the voluntary notification by doctors to the General Register Office through local medical officers of health of all congenital malformations present at birth, whether the baby is alive or stillborn. Thus a central register will be kept and any national or regional variation in incidence detected. Had such a register been in existence during the time that thalidomide was in use the remarkable increase in incidence of rare limb deformities would have been noticed at a much earlier date.

Drugs affecting the cardiovascular system

Although digitalis crosses the placenta it has no harmful effect on the fœtus. Anticoagulants of the dicoumarol group, however, have caused placental separation and haemorrhages in the fœtus with intrauterine and neonatal death and they should therefore only be used in pregnancy when their need is urgent because of a threat to the mother's life from thrombosis or embolism. The antihypertensive drugs bretyllium and guanethidine appear to be harmless to the fœtus, but the ganglion-blocking agents, such as hexamethonium, may produce meconium ileus or neonatal pneumonia. Reserpine may cause a non-infective nasal discharge in the infant for a few days after birth. Although fœtal bradycardia may follow the use of protoveratrine no harmful effects result. Both atropine and scopolamine accelerate the fœtal heart rate but adrenaline and nor-adrenaline tend to slow it, such effects being transitory and not permanently harmful.

Antibacterial drugs

Sulphonamides compete effectively with bilirubin for binding sites on serum albumen and thus there is a risk of kernicterus developing after birth. Other drugs such as salicylates and caffeine sodium benzoate act in a similar way and therefore it is wise to withdraw these drugs before labour, especially if there is any likelihood of prematurity or rhesus incompatibility. The milk teeth of children born to women who have received tetracyclines in pregnancy may be stained yellow; fortunately

this does not seem to affect the permanent teeth. Although there is a theoretical risk of nerve deafness or disturbance of vestibular function in the newborn after giving streptomycin to the mother, for there to be any adverse effect the drug has to be given in high dosage for a prolonged period, and in ordinary dosage it is safe. Penicillin, tetracyclines, erythromycin and vancomycin all pass from the mother into the fœtal blood and amniotic fluid but have no harmful effect.

Hormones

Androgens such as testosterone and methyl testosterone should not be given to the mother during pregnancy since they may cause virilization of the female fœtus. However, related synthetic progestogens are frequently given in cases of threatened or habitual abortion and virilization has been reported in female infants. Some progestogens, such as norethynodrel, dydrogesterone and allylestrenol, are said to be safer than others, such as ethisterone and norethisterone; and 17a-hydroxyprogesterone caproate appears to be without virilizing effect. It remains to be seen how effective progestogen treatment is in preventing abortion.

Adrenal steroids, such as hydrocortisone 50 mg. daily, may be given in physiological doses to pregnant women with Addison's disease, or to those who have had bilateral adrenalectomy, without any risk of producing fœtal malformation. In certain rare diseases such as lupus erythematosus, nephrotic syndrome, polyarteritis nodosa, status asthmaticus and idiopathic thrombocytopænic purpura, adrenocortical steroids are used in pharmacological doses. There is a small risk of cleft palate in the fœtus if they are given, but since this risk is only of the order of about 1 per cent treatment essential for the mother should clearly be continued.

Anti-emetic drugs

Many anti-emetic drugs were thought to be teratogenic as a result of the discovery that thalidomide taken by the mother caused fœtal limb deformity. Among these were meclozine, stelazine and stematil, drugs that are taken in the early weeks of pregnancy during a critical time of fœtal development. More careful prospective observation has shown that the incidence of fœtal malformations which has followed the use of these drugs has been the same as if no drugs had been taken. They are therefore no longer believed to be the cause of such congenital malformations.

Other drugs

' Radioactive isotopes of iodine, strontium and phosphorus cross the placenta and become localized in fœtal tissue. Neither these substances nor those which do not cross the placenta but emit gamma rays should be used in pregnancy. Radioactive iodine (I^{131}) is taken up by the fœtal

thyroid and may lead to hypothyroidism. Anti-thyroid drugs, such as the thiouracil group, or large doses of iodine may cause fœtal goitre, hypothyroidism and cretinism. Surgery is therefore the treatment of choice for thyrotoxicosis in pregnancy. The anti-metabolite drug, aminopterin, given in early pregnancy causes either abortion or fœtal malformation. Anti-metabolite drugs, such as methotrexate and 6-mercaptopurine, and cytotoxic drugs, such as nitrogen mustard, chlorambucil and busulphan, are not likely to be called for in pregnant women, but if there is a disease such as leukæmia in the mother it may be necessary to give one of these drugs in spite of the risk to the fœtus.

OBSTETRICAL DIAGNOSIS

CERTAIN terms used in connexion with the fœtus and its relation to the uterus must be explained.

Lie. By the lie of the child is meant the relation which the long axis of the fœtus bears to that of the uterus. The lie may be longitudinal, oblique or transverse.

Presentation. The presenting part of the fœtus is that part which is in relation to the cervix and can be felt on vaginal examination. When the head occupies the lower segment of the uterus the presentation is cephalic; if the head flexed on the spine, the presentation is a vertex; if fully extended on the spine, a face presentation; if midway between flexion and extension, a brow presentation. If the breech occupies the lower part of the uterus, the presentation is a breech. If a knee or a foot lies lowest, the presentation is said to be a knee presentation or a footling, both of which are varieties of breech presentation. If the fœtus lies obliquely, the shoulder generally lies over the internal os, so that it is called a shoulder presentation.

Position. By the term position is meant the relation which some given part of the fœtus bears to the maternal pelvis. The indicator is a selected point on the presenting part, and the position may be defined from the relation of the indicator to four arbitrarily chosen points on the pelvis. These are the right and left ilio-pectineal eminences and the right and left sacro-iliac joints. For example, the indicator of the vertex presentation is the occiput. If the occiput is to the maternal left side and anterior the fœtus is said to be in the left occipito-anterior position (L.O.A.). If the back of the fœtus is directed to the front, it is a dorso-anterior position, if to the back, a dorso-posterior.

Attitude. The term attitude refers to the relation of the different parts of the fœtus to one another. If the back, head and limbs are flexed, the fœtus is said to be in an attitude of flexion; if extended, in an attitude of extension. The usual attitude is one of flexion. The back is arched, with a dorsal convexity; the head is flexed towards the chest; the thighs are bent up towards the abdomen; the knees are bent, and so are the arms and forearms.

In 96 per cent of cases at term the fœtus lies longitudinally, with the head in the lower uterine segment, and the breech in the fundus. The reason for this is found in the fact that at full time the fœtus has to adapt itself to the shape of the uterus. In the early months of pregnancy the liquor amnii is comparatively more abundant, and the fœtus can float

freely; but as pregnancy advances, and the fœtus rapidly increases in size, the quantity of liquor amnii becomes comparatively less. Consequently, at term the fœtus can no longer float freely, but has to adapt itself to the shape of the uterus. When the attitude is one of complete flexion, the buttocks with the adjacent parts of the thighs and the feet constitute a mass larger than the head. The cavity of the uterus at full time is pear-shaped, with the larger end uppermost; therefore the fœtus fits into it best when the breech lies in the upper part of the uterus, and the head in the lower part.

In premature labour, presentations other than those of the head are much more common than in full-time labour—for two reasons: first, because the liquor amnii is comparatively more abundant, and, secondly, because the head is comparatively larger in premature children than in those born at term.

If the head is disproportionately large at full time, e.g. in hydrocephalus, the fœtus is likely to present by the breech, the enlarged head being larger than the breech, and so occupying the fundus, the larger end of the uterus.

If there is excess of liquor amnii (hydramnios), malpresentations are likely to result, the fœtus being able to move about freely, and not having to adapt itself to the shape of the uterine cavity.

If the head cannot readily enter the brim of the pelvis, a malpresentation is likely to occur. This may be seen when the pelvis is contracted or a placenta prævia or pelvic tumour diminishes the space available.

If the tone of the uterine and abdominal muscles is poor, as is often the case in patients who have had a large number of children, the factors which normally produce a longitudinal lie no longer exist and the fœtus may lie transversly or obliquely. When the tone of the uterus improves just about the time of the onset of labour, this abnormal lie may be corrected provided that the membranes have not ruptured.

The movements of the fœtus also assist in making it assume a longitudinal lie. A shoulder or breech presentation is more likely to occur with a dead than with a living child, because of the absence of movements and the absence of the child's muscle tone.

The back of the fœtus is much more commonly directed towards the front than towards the back of the mother. The fœtus adapts itself to the shape of the uterine cavity; which must, during relaxation, be much less concave behind than in front, because of the convexity forwards of the lumbar part of the spine on which it lies. The concavity of the fœtal body fits the convexity of the maternal spine when the back of the fœtus is directed forwards.

If the back of the fœtus is directed towards the back of the mother, the two convexities are in contact, and the fœtus cannot fit the shape of the uterine cavity unless its back is less flexed than normal.

In cases in which the mother's abdominal wall is weak (pendulous belly), the uterus sags forward, and the fœtal attitude is one of extension so that a face or brow presentation may result.

The pregnant uterus has usually a slight right lateral obliquity, i.e. it leans towards the right side. There is usually also some rotation to the right, the anterior surface looking slightly to the right. The transverse diameter of the uterine cavity is thus in the right oblique diameter of the mother's abdomen. The antero-posterior diameter of the child occupies this, the greatest diameter of the uterus when the back lies in front and to the left.

Abdominal examination

Abdominal examination is most important, and should always precede vaginal examination.

By abdominal examination it is possible to ascertain:

1. The size of the uterus and to note whether it corresponds with the period of amenorrhœa.
2. The lie, presentation, position and attitude of the fœtus.
3. Whether the presenting part has entered the pelvis or not, and so to form an idea as to the relative sizes of the presenting part and the brim of the pelvis.
4. The presence of abnormal conditions, such as excess of liquor amnii, twin pregnancy and abdominal tumours.
5. Whether the child is alive or not.
6. Some idea as to the size of the child.

The patient should lie on her back, with her head on a pillow her abdomen uncovered, and her knees slightly drawn up.

Inspection. The examination should begin by a careful inspection of the abdomen. The height of the fundus and the general shape and size of the uterus can always be seen. In most cases fœtal parts and fœtal movements may be seen. In primigravidæ with the head engaged in the pelvis, if the back of the fœtus is to the front, the abdomen will appear to rise smoothly from the symphysis pubis. If the occiput is posterior, a flattening of the abdomen may be observed above the pubis. If the head is unduly large it may be seen above the pelvic brim and occasionally the head can be seen in the fundus in a breech presentation. If the lie is transverse the uterus will appear wider than usual though the height of the fundus may be a little lower than in a longitudinal lie. If twins are present the uterus also appears wide but the height of the fundus will be above the normal.

Palpation. The fingers of both hands must be used, and laid nearly flat on the abdomen. The hands must be warm, and the patient, if nervous, must be engaged in conversation and put at her ease.

As the majority of fœtuses present by the vertex, the lower part of the uterus should be palpated first to establish definitely that it is a vertex

presentation and because no opinion is of any value *until the head has been identified. This is done by standing on the patient's right side, facing her feet and placing both hands on the lower abdomen above the pelvic brim* (Fig. 48). The head is recognized because it is rounder and harder than the breech. The mobility will depend upon its relation to the pelvic brim. If it is completely above the brim it is freely movable and is spoken of as a 'floating head' and the fingers of both hands can be made to meet below it; if the widest diameter has passed through the brim, the head is usually fixed and is said to be engaged in the brim; if it is deeply sunk in the pelvic cavity it may be difficult to feel at all though usually with persistence it can just be reached by the finger tips. In this method of examination the forehead is more easily felt when the head is well flexed, because it lies at a higher level than the occiput. Palpation of the lower part of the uterus is easier if the patient is encouraged to breathe deeply. The abdominal muscles relax in the phase of expiration. Alternatively the patient may relax if she is engaged in conversation.

If the head is above the brim of the pelvis, it may be felt more easily by the single-handed method shown in Fig. 49.

When the head is above the brim, moderate pressure will generally make it engage in the pelvis. This is best done by making downward pressure on the breech of the fœtus with the left hand, to bring the head over the inlet to the pelvis, and then pressing the head backwards with the right hand. Another method is to raise the patient's head and shoulders half way to the sitting position, when the head will often enter the brim. It is useful to ask the patient to raise herself so that she takes the weight of the trunk on the elbows. Perhaps the best method of all is to examine the patient when she is standing.

The fundus should then be palpated with both hands. If the breech occupies the fundus a large body will be felt, rather irregular in outline, not so round or hard as the head. When the fingers are moved downwards on to the back, they will not feel anything corresponding to the prominences of the shoulders between the breech and the trunk. A knee or a foot, or both, can generally be felt at a short distance from the breech, at a slightly lower level.

If the head occupies the fundus, a harder, rounder, smoother and more movable mass than the breech will be felt. The anterior shoulder will probably be felt, and the head can be moved independently of the body. As a rule, the small parts of the fœtus cannot be felt near the head. The fundus of the uterus is usually narrower when it contains the head than when it contains the breech.

The sides of the abdomen are next palpated to feel in which of them the back lies. If the back of the fœtus is directed more to the front than behind, a broad, smooth·resisting surface will be felt on one side of the

abdomen, and on the other side small knobs or lumps—the limbs. If these small parts are felt all over the front of the abdomen, the back must be directed to one side and backwards, and deeper palpation in the flank

FIG. 48.

The head, which is well flexed, has sunk into the brim of the pelvis too deeply for palpation as in Fig. 49; both hands must be used, the tips of the fingers being pressed in deeply at the sides of the pelvis.
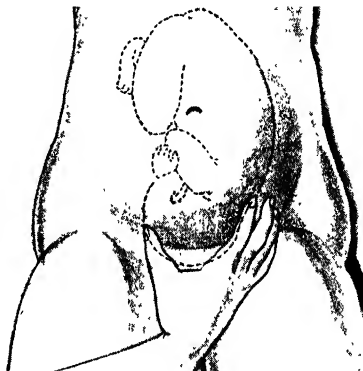
FIG. 49.   Abdominal palpation.

The head, which is well flexed, has not sunk deeply into the brim of the pelvis.
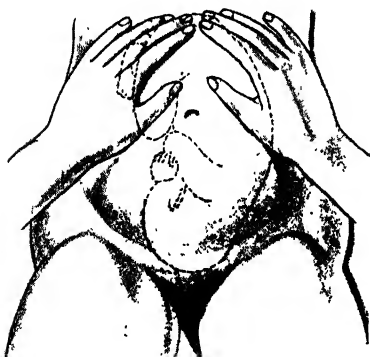
FIG. 50.   Abdominal palpation.

The breech is found to occupy the lower segment.

FIG. 51.   Abdominal palpation.

On the left side the back is felt as a broad smooth resisting surface; on the right side the limbs are felt as small movable parts.

may be necessary to ascertain on which side it lies. During this part of the examination some idea can be gained of the amount of liquor amnii that is present (Fig. 51).

If the fœtus is lying obliquely, the head will probably be felt in one iliac fossa, and the breech a good deal higher up on the other side (Fig. 52).

The presence of twins may be diagnosed by the palpation of more than two fœtal poles.

Auscultation. The fœtal heart must next be listened for. It is heard best by listening over the back of the fœtus in vertex and breech presentations, and over the chest in face presentations. It may be heard over a large area in some cases. If the back is felt in front and to one side in a

FIG. 52.   Abdominal palpation.
The fœtus is lying obliquely. The head can be felt in the left iliac fossa, and the breech at a higher level on the right side.

vertex presentation, the heart will be best heard an inch or two to that side of the middle line. Take the mid-point of the inguinal ligament, and imagine a line drawn from this point to the umbilicus. The middle of this line is the best place at which to listen.

In *occipito-posterior* positions—i.e. when the back is directed to one side and backwards—the heart is best heard either in the flank or in the middle line.

In *breech presentations* the heart will often be heard at a point higher up than in vertex presentations—at the level of, or a little above the umbilicus. The reason for this is that the breech does not engage in the brim so early in labour as does the vertex; it sits on the brim rather than in it, except in cases of extended legs.

When the back is extended, in *face presentation,* the fœtal heart is best heard on the side on which the limbs are felt—i.e. by listening over the fœtal chest, not over the back.

Vaginal examination

A vaginal examination is usually made at the patient's first attendance at the antenatal clinic (see p. 96), but this is seldom the best time to try

to estimate the capacity of the pelvis. In most clinics the measurements of the pelvis are taken about the 36th week, by which time the tissues have softened and relaxed, and examination is easier. In making a vaginal examination during pregnancy routine antiseptic precautions should be taken.

The examination may be made either with the patient on her back or on her left side. The vulva should be inspected and, prior to examination, it should be swabbed with an antiseptic lotion. A sterile glove should be worn, and an antiseptic cream used as a lubricant. The first and second fingers are inserted into the vagina, and as the fingers enter, the angle made by the pubic bones where they join at the symphysis may be noted. Some impression of the shape of the pelvis may be gained by palpating the ileopectineal line at the brim of the pelvis, and the ischial spines can be felt and a rough estimation of their distance apart may be made.

The anterior surface of the sacrum should be palpated to estimate whether it is concave or flattened and an attempt should be made to feel the promontory of the sacrum; if it is felt the measurement of the diagonal conjugate should be made. These observations are best made in the antenatal department, but if a patient is first seen in labour, they should be attempted at that time. In labour the most important observations will be the degree of dilatation of the cervix, whether the membranes are ruptured or not, and the recognition of the presenting part and the estimation of its position in the pelvis.

Occasionally vaginal examination may be difficult, either because of obesity or because the patient is unusually sensitive; in such cases an anæsthetic should be given.

In all cases in which there is difficulty in determining the presentation and position of the fœtus or the size of the pelvis, an X-ray examination should be made.

X-ray examination

In any case in which there is difficulty in making a diagnosis or in which the findings suggest an abnormality, a radiograph will very often be of great help. Unfortunately there is some evidence that exposing the fœtus to irradiation, particularly in the early weeks of pregnancy, may be injurious. It is known that excessive exposure may produce fœtal abnormalities and may also cause abnormal mutations in the genes of the sex cells. A recent study has suggested that even moderate exposure may slightly increase the incidence of leukæmia during the early years of life although this conclusion has not been universally accepted. It is therefore wise to avoid X-ray examination as much as possible during pregnancy.

In many instances the difficulty of diagnosis can be resolved by a more skilful observer, or by examination under an anæsthetic. When it becomes

necessary to resort to a radiographic examination, the exposure should be kept to a minimum. A skilled radiologist with modern apparatus will be able to obtain the maximal information with the minimal risk. If the diagnosis is in doubt the life of the fœtus and possibly the mother may be

FIG. 53. Pregnancy of 36 weeks. Brow presentation.

threatened so that it is better to take an X-ray photograph even if it is associated with a small hazard. These facts should be kept in mind in considering the following points in which a radiograph may help in the diagnosis.

Diagnosis of pregnancy

Because of the dangers of irradiation to the fœtus X-rays in early pregnancy should be avoided. After the 16th week X-ray examination will, as a rule, provide positive evidence of pregnancy, and this may be useful in any case which has a medico-legal aspect.

FIG. 54.   Intra-uterine death of the fœtus.
Spalding's sign is present. There is marked overlapping of the bones of the vault of the skull.

Fœtal maturity. Although in the past many efforts have been made to estimate the maturity of the fœtus by X-rays, none of the methods has proved to be of much value. The appearance of the centres of ossification of the bones are very variable and the difficulty of their demonstration is

considerable. If the centre of ossification of the lower end of the femur can be demonstrated *in utero*, it is almost certain that the fœtus is sufficiently mature to survive birth.

It is possible but difficult to measure the fœtal skull *in utero* (cephalometry) but generally speaking a clinical estimate is quite as satisfactory.

Lie, presentation, position and attitude of the fœtus. Although these can always be determined accurately by X-rays in the later weeks of pregnancy, this should seldom be necessary. An X-ray examination may occasionally be necessary in cases of hydramnios or gross obesity.

Multiple pregnancy. The presence of twins or triplets can be diagnosed with certainty by X-rays in the later months of pregnancy. The radiological diagnosis of multiple pregnancy may be made as early as the 16th week, but one fœtus may easily be missed at this stage, particularly if there is an excess of liquor in one amniotic sac.

Fœtal abnormalities. X-ray examination should be undertaken whenever a fœtal abnormality is suspected, and in all cases of hydramnios. Anencephaly and gross hydrocephalus are easily recognized, but lesser degrees of hydrocephalus should be diagnosed with caution, as separation of the skull bones may be deceptive, and the position of the fœtal skull relative to the film may give an appearance of enlargement, especially in an antero-posterior film of a breech presentation. Spina bifida may occasionally be seen if the position of the fœtus is favourable to its demonstration, and it should certainly be looked for in cases of hydrocephalus. Gross fœtal ascites may be diagnosed by X-rays, and should be looked for when there is a possibility of hydrops fœtalis. Rare monstrous formations of the fœtus may also be detected.

Intra-uterine death of the fœtus. The most reliable sign of fœtal death *in utero* is over-riding of the bones of the vault of the skull (Spalding's sign). This sign may be demonstrable 48 hours after fœtal death, or it may be delayed for a week or more. Some over-riding of the tabular bones of the vault occurs during labour from moulding, but with this exception over-riding can be taken as a definite evidence of fœtal death. Minor degrees of over-riding should be interpreted with caution, and the absence of over-riding cannot be interpreted as evidence of a live fœtus. Marked hyperflexion of the fœtus, or contortionist attitudes of the fœtal limbs, may be taken as supporting evidence of fœtal death, but is not so reliable as Spalding's sign. The presence of gas in the vascular system of the fœtus may also be seen with a dead fœtus *in utero*.

LABOUR

PREGNANCY is terminated by the onset of labour approximately 280 days from the first day of the last menstrual period. The cause of the onset of normal labour has not as yet been determined, but certain facts are known.

The uterus normally contracts strongly to expel any foreign body or tumour (such as a fibroid) from its cavity. In discussing the cause of the onset of labour the problem is not to discover why the uterus starts to contract at term, but to find out why it remains quiescent during pregnancy. The uterus clearly has the power of expelling its contents before term, as in cases of miscarriage or premature labour, and also in cases in which labour is induced before term.

It has been suggested that the uterine muscle is inhibited during pregnancy by progesterone. In rabbits the onset of labour can be postponed by giving large doses of progesterone, but there is no evidence that this is the case in women. Nor has it been shown that the concentration of progesterone in the blood or urine falls before term.

It has also been suggested that the rising level of œstrogens during pregnancy eventually sensitizes the uterine muscle, so that it responds more easily to stimuli or to oxytocin. There is no evidence of an increasing secretion of oxytocin, and labour starts normally in hypophysectomized animals.

During normal pregnancy the growth of the uterus keeps pace with that of its contents and the limit of stretch of the wall is probably not reached even at term; the intrauterine pressure does not rise. However, in cases of hydramnios or of twins premature labour is common, so that in abnormal cases overstretching of the uterus may play some part in causing the onset of labour. In a recently reported case a patient with a double uterus had a pregnancy in each. The fœtus in one uterus was abnormal and was expelled at the 34th week. In the other uterus the pregnancy was normal and continued to term. This certainly suggests that the cause of onset of labour is local rather than systemic.

Quite apart from the natural mechanism of onset, in some instances labour may be started abnormally by stimulation of the uterus. This stimulus may be either direct, as in the induction of premature labour by rupture of the membranes, or indirect, as by violent purges and possibly by emotional shock.

Labour usually follows intrauterine death of the fœtus but there may be an interval of several days or even weeks before its onset.

During normal pregnancy the uterus contracts intermittently, but these contractions are not strong enough to overcome the resistance of the normal cervix. However, if the cervix is damaged or incompetent even these weak contractions may dilate the internal os and labour will follow.
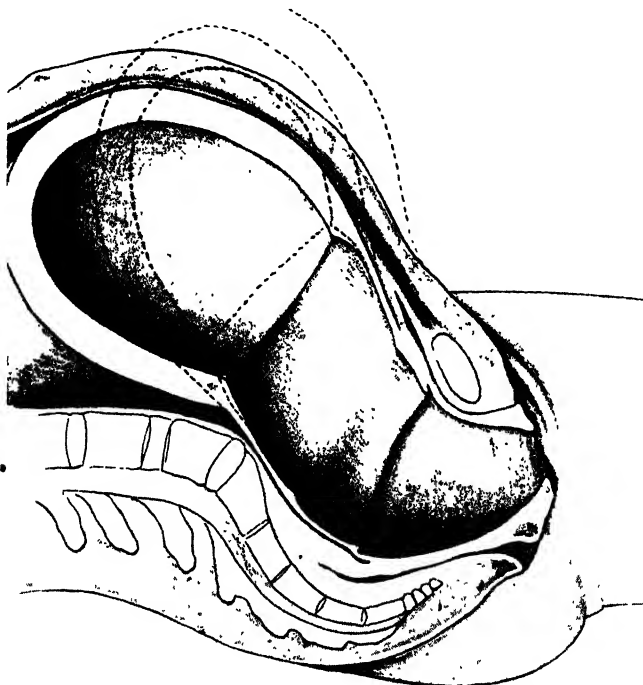
FIG. 55. Diagram to show the thickened upper uterine segment and the thin lower uterine segment.

The dotted line shows the position assumed by the uterus during contraction.

For the consideration of the phenomena of labour the uterus must be divided into three parts which behave differently during labour:

1. **Cervix.** This is dilated mechanically, playing a mainly passive part.

2. **Lower uterine segment.** At the end of labour two distinct parts of the uterus can be recognized. A thinned out and stretched lower part, or *lower uterine segment*, and a much thicker retracted part, the *upper uterine segment*. The transition from upper to lower segment is quite abrupt. Although strictly speaking there is no lower uterine segment before the onset of labour it is customary to refer to that part of the lower pole of the uterus which will become stretched out and thinned by this name. At term the lower uterine segment extends upwards for about 7·5 cm. (3 inches)

above the internal os. A definite anatomical landmark cannot be given as the upper limit of the lower uterine segment, except that in front it corresponds with the lower limit of firm attachment of peritoneum to the uterine muscle. The lower uterine segment has its shape altered during labour from that of a hemisphere to that of a cylinder, its walls becoming stretched and thinned as labour advances until there is room for the fœtus to pass through'(Fig. 56).
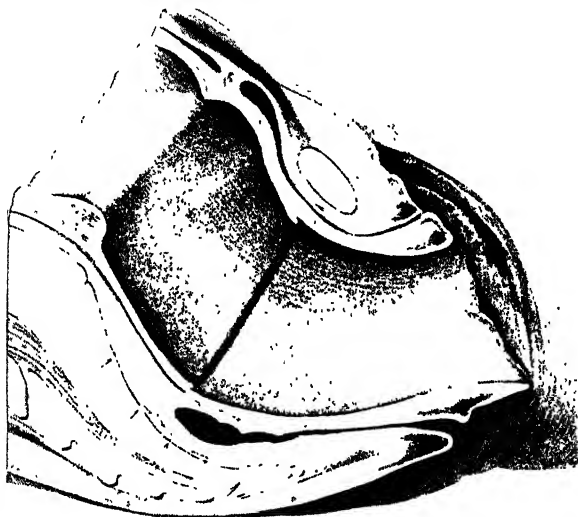
FIG. 56.   The birth-canal.

The lower uterine segment, cervix, vagina, pelvic floor and vulval outlet have been dilated and form a continuous canal. There is still a slight ridge marking the lower limit of the cervix.

3. **Upper uterine segment.** This comprises the greater part of the body of the uterus. The walls of this part of the uterus become progressively thicker from retraction of the muscle fibres as labour advances, and as the contents of the upper uterine segment are more and more accommodated in the lower segment and cervix.

In labour the lower uterine segment, cervix, vagina, pelvic floor, and vulval outlet are dilated until there is one continuous birth-canal (Fig. 56). The forces which bring about this dilatation and expel the fœtus are supplied by the contraction and retraction of the muscle of the upper uterine segment, with assistance in the second stage from the abdominal muscles, including the diaphragm.

The muscular fibres of the upper segment of the uterus can contract, relax and retract. When contracting, the fibres become shorter and thicker. In retraction they do not return to their original length but remain

shortened although the active contraction has passed off. In relaxation muscle-fibres lengthen and become thinner, returning to the original length. If contraction is followed by relaxation, only temporary shortening is produced. If retraction accompanies contraction, some of the shortening of the muscle-fibres is permanent. Retraction is a property which, though not peculiar to uterine muscle, is more marked in the uterus than in any other organ. It is evident that retraction occurs independently of active contraction and, moreover, contraction can be superimposed on retraction. If there is no retraction, each individual contraction starts at the same point, as regards the size of the uterus, as its predecessor. When retraction is present, however, each successive contraction starts at the point where its predecessor left off, the uterine cavity becoming permanently smaller as the result of each successive contraction, thus preventing the child slipping back.

When the fœtus is being expelled, the retraction of the uterine muscle keeps the inner surface of the uterus in contact with the fœtus, as if it were moulded to it. When the placenta is expelled, retraction enables the uterine walls to come together so that there is only a potential cavity.

For the pathological effects of retraction see Obstructed Labour (p. 336).

During pregnancy the internal os is kept closed, by the contraction of its circular fibres, such as occurs in the sphincter muscles of other hollow viscera. Throughout pregnancy with increasing frequency irregular painless contractions of the muscular fibres of the body of the uterus occur, followed by relaxation and accompanied by only a minimal amount of retraction. It is this small amount of retraction which is responsible for the dilatation of the lower segment and cervical canal found in many primigravidæ in the last weeks of pregnancy.

Forcible dilatation of the internal os stimulates contraction of the body of the uterus, and conversely contraction of the body of the uterus causes dilatation of the cervix. This has been referred to as the polarity of the uterus.

The stages of labour

Labour is divided into three stages:

1. The *first stage*, or stage of dilatation, lasts from the onset of the true labour pains until the os uteri is fully dilated.
2. The *second stage*, the stage of expulsion of the child, lasts from the full dilatation of the os uteri until the child is born.
3. The *third stage* lasts from the birth of the child until the placenta and membranes are delivered and the uterus has retracted firmly to compress the uterine blood sinuses.

Premonitory symptoms. In most primigravidæ, the presenting part sinks into the pelvis during the last 3 or 4 weeks of pregnancy, and this is spoken

of as 'lightening' because the descent of the uterus reduces the upper abdominal distension, making the patient more comfortable.

In many multiparæ the presenting part does not engage until labour begins. In some the presenting part goes into the pelvis 2 or 3 days before the onset of labour, and such experienced patients may recognize that labour is likely to start within a few days.

Multiparæ not infrequently have uterine contractions which are strong enough to be painful for some days before real labour starts. Such 'false pains' only differ from 'labour pains' in that they are ineffective in dilating the lower uterine segment and cervix.

Symptoms and signs of the onset of labour

These are three: (1) the pains; (2) the shortening and dilatation of the cervix; and (3) the show.

1. **The pains.** As has been stated earlier the uterus contracts irregularly and painlessly throughout pregnancy (Braxton Hicks contractions). Labour is recognized by the changes which take place in these contractions, in that they become regular and painful enough to distract the patient from her normal activities. The difference is due to the fact that in labour contraction is followed by retraction, so that the next contraction must cause some corresponding dilatation of the lower segment and cervix. The uterus can be felt to harden during each contraction which begins gradually, works up to a period of maximal intensity and then dies away. At the onset of labour the interval between contractions is about 20 minutes but it is typical of normal labour that the contractions increase in frequency, strength and in their painful quality, until at the end of the first stage they are coming every 3 minutes and lasting as long as 1 minute.

The pains are spoken of as being involuntary, inhibitable, peristaltic, and intermittent. Although they are beyond the control of the patient's will, occurring even when she is unconscious, they may be inhibited, lessened in frequency, or temporarily abolished by emotion or by distension of bladder or rectum; also they may be increased in strength and frequency by such stimuli as a purgative, a hot enema, stretching of the cervix or perineum by the presenting part, or by an injection of oxytocin.

The pain of labour has the same character as that of spasmodic dysmenorrhœa and is probably due to the same cause—ischæmia of the uterine muscle due to compression of the blood-vessels in the wall of the uterus. It is analogous with myocardial pain which occurs when the blood flow in the coronary arteries is restricted. The fact that the contractions are intermittent and not continuous is of great importance to both the fœtus and the mother during the first and second stages of labour. During a pain the circulation through the uterine wall is stopped, and if the uterus

contracts continuously the fœtus dies from lack of oxygen. The intervals between the pains allow the placental circulation to be re-established, and give the mother time to recover from the fatiguing effect of the contraction. The uterus is a very large muscle, and a long-continued contraction uses up much of the patient's energy. This recurring drain on her strength, if allowed to continue for too long, produces maternal exhaustion.

Electrical records of the pattern of uterine contractions show that in normal labour each contraction starts near one or other uterine cornu. The contraction spreads as a wave in the myometrium, taking 10 to 30 seconds to spread over the whole uterus. At each point reached by the wave the contraction takes about another half minute to reach its peak.

The upper part of the uterus contracts more strongly than the lower part, and the duration of the contraction is longer in the upper than in the lower segment. This dominance of the fundus leads to the stretching and thinning of the weaker lower segment and to dilatation of the cervix.

If the wave pattern is abnormal, with the lower part of the uterus contracting first or as strongly as the upper part, no progress in labour will be made. In other abnormal cases the wave spreads erratically in the myometrium and the contractions are inco-ordinate.

2. **Shortening and dilatation of the cervix.** If the cervix is not sufficiently dilated to allow the finger to feel the bulging of the bag of membranes during the pains, its shortening is the safest sign on which to base an opinion that labour has begun. At the beginning of labour the cervix of a woman who has not borne a child before is often a thick-walled canal at least an inch long. In other cases the cervix may be found to be completely taken up and partly dilated in the latter weeks of pregnancy, particularly after Braxton Hicks contractions have been experienced.

When labour begins the contraction and retraction of the longitudinal fibres of the upper uterine segment stretches the lower uterine segment and the upper part of the cervix, while the lower part of the cervical canal remains at first unaltered. As the internal os is dragged open, the cervix is dilated from above downwards, becoming shorter and shorter, until at length no projection into the vagina is left, but only a more or less thick rim at the external os, the whole cervix being taken up, and its cavity made one with the cavity of the body of the uterus. Without true shortening of the cervix it is unwise to diagnose that a primigravida is in labour (Figs. 57–60).

In women who have borne children, the external os will often admit the finger before labour has begun, and the finger-tip can sometimes be passed through the internal os. Very often the cervix has been completely taken up. In this case the projection of a small bag of membranes during a pain will be a proof that labour has begun.

3. **The show.** This is an increase of mucous discharge from the cervix, mixed with a little blood. As the internal os is pulled open, the membranes are separated from the lower uterine segment, and a variable amount of oozing of blood results. Its absence cannot be taken as a proof that labour has not begun.

FIG. 57.   FIG. 58.

Dilatation of the cervix in labour, from above downwards. In the left figure the cervical canal is intact. In the right figure the internal os and the upper part of the canal have been dilated while the lower part of the canal is unaltered; shortening of the cervix has occurred.

FIG. 59.   FIG. 60.

Further stages of dilatation of the cervix. In the left figure the cervix is fully taken up. In the right figure the cervix is partly dilated.

4. **Rupture of the membranes.** When the membranes rupture spontaneously near term it is probable that labour will begin within a short time and it may mean that labour has already begun, although in a few instances the onset is still delayed.

The first stage of labour

The effect of the contractions of the uterus is to increase the general intra-uterine pressure. At the same time the contraction and retraction of the longitudinal fibres open up the cervix. The dilatation of the internal os must cause a separation of the chorion from the decidua in its immediate neighbourhood. Thus a small bag of membranes, the separated part of the chorion with the amnion and the amniotic fluid inside it is formed, and this bag of membranes is forced into the internal os by the increase of intra-uterine pressure. The bag of membranes makes a satisfactory dilator of the cervix—a fluid wedge which is forced farther and farther into the cervix, exerting pressure on, but doing no harm to, the maternal tissues. So long as the bag of membranes remains intact neither mother nor fœtus can suffer any injury from pressure. At the beginning of a pain a little more liquor amnii is forced into the bag of membranes, the head then comes down as a ball-valve and separates the liquor amnii which is left in the uterus from that which is in the bag, called respectively the hind-waters and forewaters. Normally the bag of membranes dilates the cervix until the os is about 10 cm. (4 inches) across, and then ruptures, being no longer supported by the margins of the os. If the presenting part does not fit the lower uterine segment closely, the bag of membranes is likely to be pressed down in an elongated form, like the distended finger of a glove, and to rupture before the os is fully dilated. This may occur with any malpresentation and with a contracted pelvis.

During the first stage the fœtus is moved downwards only a very little. When a certain amount of liquor amnii has left the uterus, a good-sized bag of membranes having been formed, a new form of pressure comes into play, viz. the fœtal axis-pressure, due to the direct pressure of the uterus on the fœtus. The extent to which this force acts in the first stage of labour is indirectly proportional to the amount of liquor amnii. When there is a deficiency of liquor amnii the fœtal axis-pressure will come into play early. The upper pole, normally the breech, is pressed on by the fundus of the uterus, while the lower pole is pressed down on to the lower uterine segment and cervix.

During the early part of the first stage the pain is usually not very severe, and the mother should be encouraged to remain up and about. Towards the end of the first stage, however, the pains may be very distressing to the patient, recurring frequently and, as advance is not perceptible to her, apparently doing no good. Vomiting is not uncommon towards the end of the first stage. The pains of this stage are, until near the end, purely involuntary, the patient not making use of her voluntary muscles as she does during the second or expulsive stage.

The pain later in the first stage is due partly to the ischæmic pain of uterine contraction, and partly to the stretching of the cervix.

Disadvantage of too early rupture of the membranes. In the past much has been written of the disadvantage of early rupture of the membranes but today it is agreed that in normal vertex presentations at least, early rupture is of little disadvantage. In some patients the membranes rupture before the onset of labour, and artificial rupture of the membranes is the most satisfactory method of inducing labour; in such cases the labour follows a normal course.

During the course of labour, so long as the bag of membranes remains intact, the rise in intra-uterine pressure is distributed equally over the foetus. This is still true in a normal case after the rupture of the membranes, except for the small part of the foetus exposed at the dilated cervix, because the well-fitting presenting part prevents much liquor from draining away. If, however, there is a malpresentation, or if labour follows an abnormal course, because the presenting part does not fill the lower segment, early rupture of the membranes may be followed by the loss of the greater part of the liquor, and the uterus may become closely applied to the foetus, so that during contraction it may be grasped rather than expelled. It is in these cases of malpresentation and in those in which there is a slight disproportion between the foetal head and the maternal pelvis that the intact membranes are so advantageous. Unfortunately these are the cases in which early rupture is likely to occur. If the membranes do rupture early in such cases, the anterior lip of the cervix may become nipped between the presenting part and the pelvis, and may become swollen and œdematous, adding to the difficulties of the labour. There is also an increased risk of infection spreading up to the foetus and the cavity of the uterus especially if labour is prolonged. If most of the liquor has drained away, the foetus, the cord and the placenta may all be unduly compressed by the retraction of the uterus, so that if labour is prolonged, the foetus may die.

Disadvantages of too late rupture of the membranes. If the membranes remain unruptured when the os is fully dilated, the onset of the expulsive pains is retarded, the cervix not receiving the pressure of the hard head which should stimulate the uterus to increased activity. The amnion, which is a tough, strong membrane, is likely to be pushed through the chorion, which is weaker and more easily torn. If the part of the amnion which forms the bag of membranes does not rupture before the head is born, it may tear higher up or may not tear at all, the head in either case being born with a bag of amnion covering it. This condition, in which the child is said to be born with a caul, may cause its death from suffocation if a doctor or nurse is not present. If the bag of membranes remains intact after full dilatation of the os, it should be ruptured by pressure with a blunt instrument during a contraction.

The second stage

After the rupture of the membranes and escape of some of the liquor amnii it is not uncommon for a short pause to occur before the onset of the typical expulsive pains, the uterus, as it were, collecting itself before making more vigorous efforts. In some multiparæ, however, the child may be born almost immediately after rupture of the membranes.

There is very little descent of the fœtus during the first stage. The resistance offered by the cervix and lower uterine segment has now been overcome, and the presenting part can be pushed down on to the pelvic floor, the resistance of which has then to be overcome by the downward pressure of the uterine contractions, aided by the action of voluntary muscles—the muscles of the abdominal wall and the diaphragm.

The pains of the second stage of labour are stronger and of longer duration than those of the first stage, and the intervals between them are shorter. Towards the end of the second stage each contraction may last as long as a minute or more, with intervals of 2 or 3 minutes, and at the end the contractions may be almost continuous.

The pain suffered during the second stage is often not quite so severe as that at the end of the first stage. The patient too, feels that some progress is now being made and that she can help. As the head passes through the pelvis the patient may complain of cramp in the legs due to pressure on the sacral nerves. The most acute pain is felt, in first labours, during the forcible stretching of the vulva.

The character of the pains is different from that of the pains of the first stage. The patient may cry out as the contractions come on, but she generally takes a deep breath, and then holds her breath and bears down with all the force of her expiratory muscles, often crying out again as the contraction passes off. During the height of the pain there may be expiratory groans. These expiratory or expulsive efforts are partly voluntary but largely reflex due to the presence of a foreign body in the vagina.

During a contraction the rate of the fœtal heart-beat is slowed. Unless the child is beginning to suffer from the long-continued pressure, either on the placental-site circulation or on its head, or both, the heart-beat regains its normal rate between the contractions.

The presenting part is forced down with each contraction on to the pelvic floor, distending this structure and pressing it downwards. During the intervals between the contractions, however, the pelvic floor pushes the presenting part up again. Retraction now plays an important part, the cavity of the uterus remaining a little smaller after each successive contraction than it was before it, so that the progress made by each contraction is not completely lost during the succeeding interval. In a primigravida the head will be seen at the vulva for a considerable time before it can emerge. Finally, after being pushed down many times by the

uterine contractions and slipping back in the intervals between them, a time comes when it remains stationary at the end of a contraction, distending the vulval orifice. This is called the crowning of the head. The next contraction generally expels the head, which emerges in a downward and forward direction. It is important for the student to realize the extent to which the head goes forward. The uterus and abdominal muscles are pressing the head mainly downwards, while the muscles of the pelvic floor are pressing upwards and forwards. The resultant of these two forces is mainly forwards. The axis of the outlet of the bony pelvis is downwards and forwards, that of the soft parts below the bones is almost directly forwards.

As the head passes through the vulva of a primigravida the pain due to the stretching of the vulval orifice will be very severe, and will probably cause the patient to cry out, and so cease from bearing down. To some extent, this saves the perineum because it is more likely to be torn if the patient bears down hard while the head is passing through the vulval orifice.

The body of the child is generally born by the next contraction if not by the contraction which expels the head, followed by a gush of liquor amnii, mingled with blood.   ˎ

The caput succedaneum. That part of the head which is most in advance is free from pressure, while all the rest of the head is pressed upon. Consequently, as a result of the venous congestion, serum is exuded and an œdematous swelling forms on the scalp, superficial to the periosteum of the cranial bones and not limited to them. This is known as the caput succedaneum.

The caput succedaneum, unlike the cephalhæmatoma, to be described later, does not increase in size after birth, but gradually disappears in the course of a few hours or days.

If some other part presents, e.g. the face or breech, a swelling will be formed over the part most in advance exactly comparable with that on the head.

Moulding. The change in the shape of the head by which the diameters of the skull most pressed upon become diminished in size is called moulding and is brought about by pressure. The importance of moulding of the fœtal head during labour can be best appreciated by observing patients with slight disproportion who deliver themselves safely. The bones of the base of the skull are incompressible, and are joined to each other in such a way that movement is not possible between them, but the bones of the vault of the skull are compressible, and the sutures allow of a certain amount of movement between the individual bones. The parietal bones

and the tabular portions of the occipital and frontal bones can be bent by pressure, and when much compressed, the parietal bones override the occipital and frontal bones, and the anterior parietal bone, being less pressed on than the posterior, overrides its fellow. This knowledge may may be of practical importance in the diagnosis of the position of the fœtus by vaginal examination during labour.

The third stage

The uterus follows down the body of the child, and after its expulsion the fundus reaches up to a point a little below the umbilicus.

As a rule, contractions are absent for a few minutes after the expulsion of the child and the uterus, which now contains only the placenta and membranes, remains retracted without active contractions. Sometimes, in the absence of artificial stimulation, there may not be any marked contractions for an hour. During this time, however, the hand placed lightly on the uterus will feel slight rhythmical contractions, not severe enough to be noticed by the patient. After a time, which varies very much in different cases, the placenta is expelled either into the vagina or through the vaginal orifice.

As the uterine walls become thicker and the internal surface of the uterus becomes smaller, the placental site shrinks with the rest of the internal surface until it reaches a stage when detachment must occur unless the placenta is abnormally adherent. Separation of the placenta from the uterine wall occurs in two ways: (1) a part of the placenta near its centre separates and bleeding occurs at this point. The next contraction will cause a further ring of separation followed by further bleeding during relaxation of the uterus. Thus the placenta is separated in a series of concentric rings. The centre of the placenta is gradually pushed down through the cervix with its fœtal surface presenting. The placenta is delivered first, dragging the membranes behind it with the amnion now outside and the chorion inside (Schultze mechanism). (2) In other patients separation of the placenta begins at its lower pole which is less well supported by the pressure of the uterus and the whole placenta is gradually driven into the cervical canal, the upper pole being the last part to leave the uterine cavity. Either the edge or the uterine surface of the placenta presents in these cases (Matthews Duncan mechanism). The separation of the membranes from the uterine wall takes place through the decidua, part of which comes away attached to the chorion, while the rest remains in the uterus. During the first stage the membranes have been separated from part of the lower uterine segment. After the birth of the child the decrease in the size of the cavity results in the membranes being thrown into loose folds and attached only in places. The expulsion of the placenta normally completes the detachment of the membranes from the uterine

wall. The amnion is a tough membrane, firmly attached to the root of the cord, and is certain to be dragged out by the placenta. The chorion is continuous with the edge of the placenta, but its intimate contact with the amnion is more important from the point of view of the third stage of labour.

There is generally a gush of blood, not amounting to more than a few ounces, just as the placenta is expelled. If the uterus does not retract well after the placenta is separated from its walls, hæmorrhage occurs; but if it is well retracted, as usually happens, there is not more than a thin trickle of blood coming away after the birth of the placenta. The uterus is then felt as a hard, round ball about the size of a fœtal head, the top of the uterus reaching up to about half-way between the pubes and umbilicus.

The average amount of blood lost in normal labour is about 280 ml. (10 ounces); about 140 ml. (5 ounces) before the birth of the placenta, and the rest with it.

Duration of labour

Labour in primiparæ lasts on an average 8 to 16 hours. In multiparæ, 4 to 8 hours can be taken as the average time. The first stage in primiparæ usually lasts 7 to 14 hours, the cervix taking much longer to dilate than in multiparæ. In the second stage the perineum and the orifice of the vagina offer much greater resistance in primiparæ than in multiparæ. In primiparæ over 30 years of age still greater resistance may be expected from all the soft parts, increasing with advancing years, although some primiparæ over 40 years of age have easy labours.

In some multiparæ labour may last only 2 or 3 hours. It is not very uncommon for the child to be born after two or three contractions after full dilatation of the os in multiparæ.

MECHANISM OF LABOUR

THERE are three varieties of cephalic or head presentation:
1. Vertex presentations, when the head is flexed on the trunk.
2. Face presentations, when the head is completely extended on the trunk.
3. Brow presentations, when the attitude of the head is midway between flexion and extension.
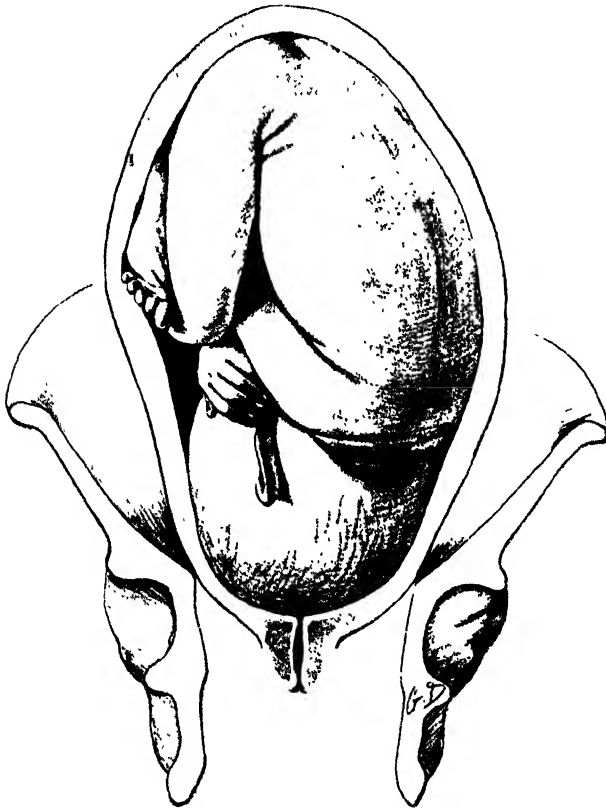
FIG. 61.   First position of the vertex, L.O.A.

VERTEX PRESENTATIONS

Vertex presentations occur in about 96 per cent of all cases of labour for reasons which were explained on page 106. The back of the fœtus and the occiput may lie in any position relative to the back of the mother.

5

Although the classical description generally describes four positions with the long axis of the head lying in one or other of the oblique diameters and the occiput either anterior or posterior, it has been shown by radiography that in the majority of cases during pregnancy the occiput lies laterally and the long axis of the head engages in the transverse diameter of the brim. When the head lies deeply in the pelvis, as it generally does
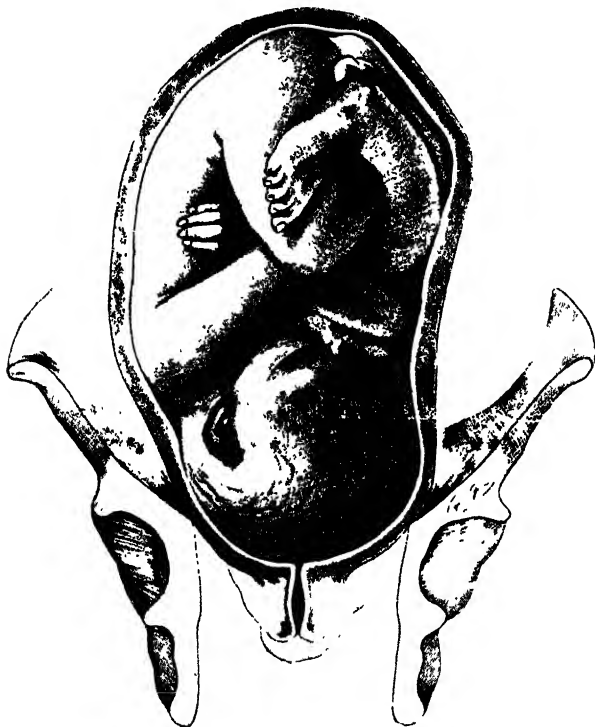
FIG. 62.   Third position of the vertex, R.O.P.

in primigravidæ after the 37th week, its long axis will often lie in one of the oblique diameters at the onset of labour. In multiparæ, however, when the head generally remains above the brim until the onset of labour the lateral position of the occiput will persist. The long axis of the head will enter the brim in the transverse diameter and will often remain in that diameter until the vertex comes in contact with the pelvic floor at the end of the first stage of labour. Because of the slight rotation of the uterus there is a tendency for the occiput to lie a little anterior to the lateral position when it is in the left side, and a little posterior to the mid line when it is on the right side. Because of this in cases in which the occiput lies to the left it

will generally rotate to the front during labour. When the occiput lies to the right, although in the majority of cases it will rotate to the front there is an increased risk that it may rotate to the back.

It is conventional (and convenient for purposes of teaching) to describe four positions of the occiput. These are: (1) The left occipito-anterior, L.O.A. The occiput is directed to the left and in front. (2) The right occipito-anterior, R.O.A. The occiput is directed to the right and in front. (3) The right occipito-posterior, R.O.P. The occiput is directed to the right and behind. (4) The left occipito-posterior, L.O.P. The occiput is directed to the left and behind.

However it should be realized that the occiput most frequently lies in a transverse position at the onset of labour and descends into the pelvic cavity in this position. In a radiological study of a series of cases the incidence of the various positions occupied by the occiput early in labour was found to be:

Position	Percentages	
Left occipito-lateral	39	⎫ 64
Right occipito-lateral	25	⎬
Left occipito-anterior	13	
Right occipito-anterior	10	
Directly anterior	2	
Left occipito-posterior	3	
Right occipito-posterior	7	
Directly posterior	1	

The conventional description of the four positions has been retained, but it will be understood that the head which lies in an occipito-lateral position will normally undergo the same process of rotation which is shortly to be described.

Although the occiput is accepted as the denominator in describing the fœtal position before labour, in actual fact the back of the fœtus is often in an obliquely anterior position when the occiput lies in the transverse diameter of the pelvis, there being a slight twist in the neck of the fœtus, e.g. with a left anterior position of the back the occiput often lies in a left lateral position. Slight variations in the shape of the brim of the pelvis probably play some part in determining in which diameter the long axis of the head will lie as it passes the brim of the pelvis.

DIAGNOSIS OF THE FIRST POSITION, L.O.A.

Abdominal examination. The breech occupies the fundus of the uterus, the back is felt to the left and in front, the limbs are felt on the right side, and the head is felt in the pelvis or, in multiparæ, at the brim, with its most prominent part on the right. The fœtal heart is best heard below and to the left of the umbilicus.

Vaginal examination. The sagittal suture is found to be lying in the right oblique diameter of the pelvis, with the posterior fontanelle in front and to the left (Fig. 63).

The anterior fontanelle lies behind and to the right, but owing to the flexion of the head, it is too high to be felt except when the patient is under an anæsthetic.

DIAGNOSIS OF THE SECOND POSITION, R.O.A.

For the diagnosis of the second position of the vertex the above paragraphs should be read with the word right substituted for left, and vice versa; the back is felt to the right with the limbs to the left, and so on.

DIAGNOSIS OF THE THIRD POSITION, R.O.P.

Abdominal examination. The breech occupies the fundus; the limbs are felt over the front of the uterus; the back is found behind and to the right, and is felt less easily than in the occipito-anterior positions. In an anterior position the resistance of the shoulder will be felt in the line between the pubes and the umbilicus. In a posterior position a definite hollow will be noticed in this position between the head and the limbs. The head is felt at the brim of the pelvis, usually higher up than in anterior positions, with its most prominent part to the left. The fœtal heart is heard best below and well out to the right of the umbilicus.

Vaginal examination. The sagittal suture is found to be lying in the right oblique diameter of the pelvis, with the posterior fontanelle behind and to the right, because the head is often less well flexed in a posterior position, the anterior fontanelle may also be felt in front and to the left (Fig. 64).

DIAGNOSIS OF THE FOURTH POSITION, L.O.P.

The two preceding paragraphs should be read with substitution of the word right for left and vice versa.

MECHANISM OF LABOUR

By the term mechanism is meant the series of changes in position and attitude which the presenting part has to make in its passage through the pelvis and the pelvic floor. The mechanism of labour should be studied with the pelvis and the dummy fœtus, as well as by careful observation during labour. For convenience we shall retain the conventional description of the four positions, but the reader should refer back to the remarks on page 130.

The head is a more or less oval body which fits fairly tightly into the canal through which it is pushed. The longest diameter of the pelvis is transverse at the inlet and antero-posterior at the outlet. At the outlet
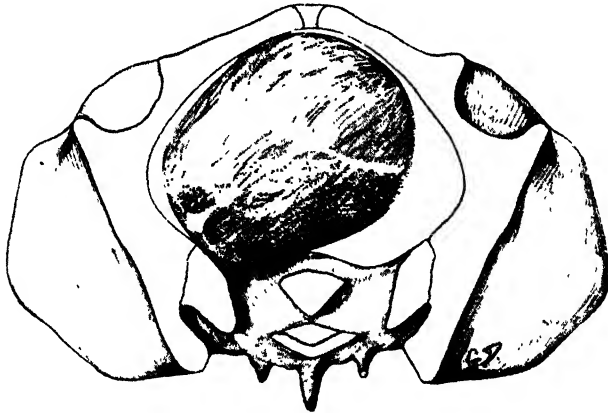
FIG. 63.

1. L.O.A.
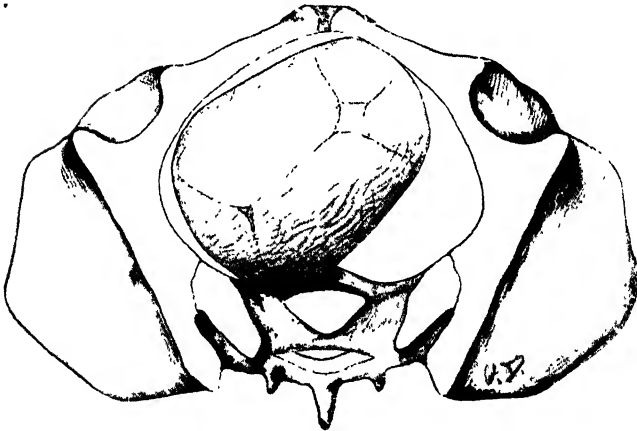
FIG. 64.

3. R.O.P.

The first and third positions of the vertex as seen from below, and as felt by the examining fingers on vaginal examination.

the pelvic floor offers resistance to the head on both sides and behind, while it leaves a free space in front. Consequently the head, which enters the pelvis in the transverse or one of the oblique diameters, does not maintain the same position throughout its passage, but undergoes some

rotation and also some change in its attitude. If the head and the pelvis are both of normal size, the soft parts have more to do with the mechanism of labour than the pelvic bones.

Mechanism. First vertex, L.O.A.

While the head is descending it makes four movements:

1.	Flexion	2.	Internal rotation
3.	Extension	4.	External rotation

Flexion. The head is flexed before labour begins, as part of the general attitude of flexion that occurs under normal conditions. If this flexion of the head is not complete before the forces of labour come into play it becomes complete—i.e. the head becomes flexed until the chin meets the chest—as the head is pressed down on to the lower uterine segment and cervix. The reasons for this complete flexion, by means of which the occiput descends more than the forehead, are (1) the shape of the head; (2) the head lever.

The shape of the head. (a) The occiput and forehead are pressed against the sides of the canal. The slope at the posterior end of the head is much steeper than is that at the anterior end, consequently the occiput can descend more easily, with less friction, than can the forehead.

(b) Any ovoid body being pushed through a tube will tend to adapt its long diameter to the long axis of the tube. When the head is completely flexed its longest diameter, the vertico-mental, is lying in the long axis of the canal, while the shortest longitudinal diameter, the suboccipito-bregmatic, is lying across the canal.

The head lever. When the breech is pressed on by the fundus of the uterus, the foetus being subjected to foetal-axis pressure, the head lever comes into play. The occipito-spinal joint is nearer to the occiput than to the forehead, so the head can be looked on as being a lever with a short posterior arm and a long anterior arm. As the foetus is pressed downwards the long anterior arm meets with more resistance, and so is more retarded than the short posterior arm—i.e. the forehead does not descend so deeply as does the occiput. The importance of the head lever has been exaggerated. There is more room in the front of the pelvis than at the back, therefore whatever part of the head is in front will descend more readily. If the occiput is in front flexion is thus favoured, as the greater resistance is posterior.

When the head is engaged in the brim, the sagittal suture is found to be lying in the right oblique diameter of the pelvis. The effect of complete flexion is to bring the posterior fontanelle, which lies in front and to the left, to a lower level than that of the anterior fontanelle, which lies to the right and behind.

Internal rotation. In the second stage of labour the head is pressed further downwards; the occiput being lower than the forehead, first meets the resistance of the pelvic floor, which can be looked on as a sloping gutter between the two levatores ani leading to a free space in front under the symphysis pubis. As the occiput is pushed down it rotates away from the resistance of the pelvic floor, moving forwards through one-eighth of a circle, along the left side of the pelvis, towards the free space under the pubic arch. The shape of the pelvis and the curvature of its axis may play some part. The largest diameter of the pelvis is transverse at the inlet and antero-posterior at the outlet and the long axis of the head will tend to rotate from the transverse to the antero-posterior as it descends. Because the axis of the pelvis is curved, it has been suggested that to pass round the curve easily the fœtus will tend to rotate, because with a well flexed head the fœtus is a relatively rigid structure except for the movement of extension of the head on the trunk. The head thus comes to lie with the sagittal suture in the antero-posterior diameter of the pelvis, the occiput and posterior fontanelle in front below the pubic arch, the forehead and anterior fontanelle behind in the hollow of the sacrum, the nape of the neck being against the back of the symphysis pubis, and the chin still in contaçt with the chest.

Extension. The head is now acted on by two forces. The uterus and abdominal muscles are pressing it downwards, while the muscles of the pelvic floor are pressing it upwards and forwards. The resultant of these forces acts in a forward direction—the downward and upward pressures counterbalance one another, and the head has to go forwards. It cannot go forward as a whole because the nape of the neck is fixed against the symphysis pubis. The only way in which the head can go forwards, as it must to follow the curve of the birth-canal, is by a movement of extension, the chin leaving the chest, and the occiput escaping under the pubic arch. The occiput is free already, and the vertex stretches the vaginal outlet until the head can emerge, the vertex forehead, face, and chin successively gliding forward from under the perineum (Fig. 65).

External rotation. There are now two movements: (1) Restitution or untwisting; (2) External rotation.

Restitution. As the head descends with its suboccipito-frontal diameter in the right oblique diameter of the pelvis the shoulders enter the pelvis in the left oblique diameter. When internal rotation of the head takes place the head is twisted a little on the shoulders. As soon as it is completely born it resumes its natural position with regard to the shoulders, turning with the occiput towards the mother's left thigh. This movement, which is performed as soon as the head is free, sometimes almost with a
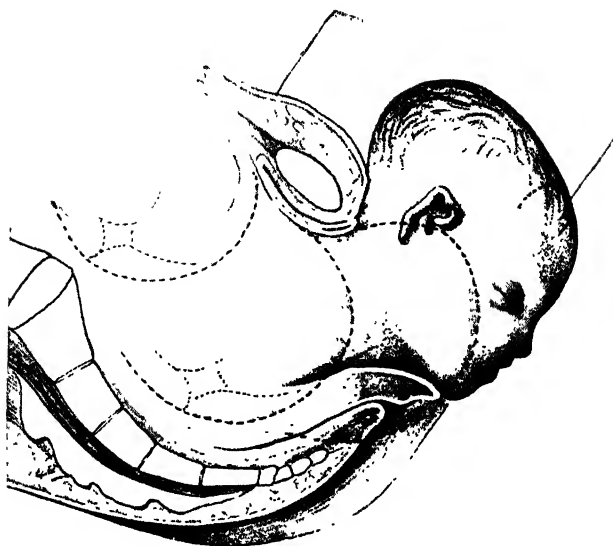
FIG. 65.   Extension of the head.

The occiput is seen to move forwards and upwards over the symphysis as the head emerges, the face and chin escaping from under the perineum.
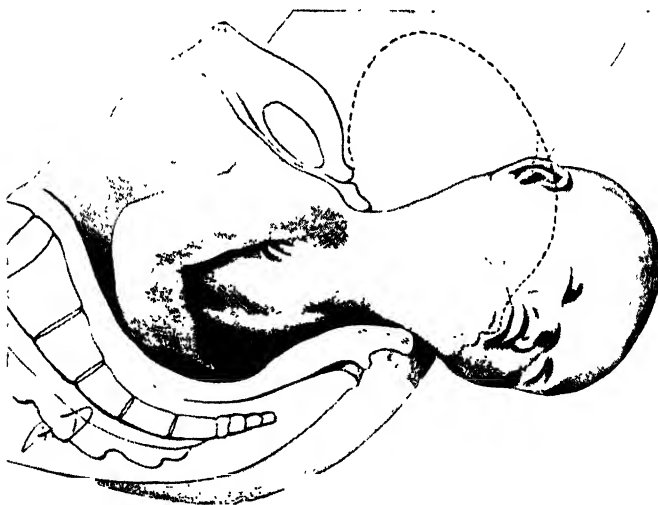
FIG. 66.   First movement of external rotation.

The head is seen to have rotated so that the face looks to the right instead of backwards as it did at the moment that the head was born.

jerk, is called restitution, because by it the neck becomes untwisted and the head is restored to its natural relation to the shoulders.

Second movement: External rotation. As the shoulders descend the right and anterior, being the lower, meets the resistance of the pelvic floor before the left, and so rotates to the free space in front, as did the occiput. The shoulders now occupy the antero-posterior diameter of the pelvis. As they rotate the head rotates with them, the occiput making a further movement of one-eighth of a circle towards the mother's left thigh. The head now lies with the face to the right and the occiput to the left (Fig. 66).

It will be noticed that the internal and external rotations are in opposite direction, the back of the head being on the same side at the end of the second stage of labour as it was at the beginning.

The shoulders then emerge, the right one escaping under the pubic arch, while the left slides over the perineum, followed by the rest of the body, which is usually born without difficulty, being smaller than either the head or shoulders. The arms are usually folded on the chest, with the hands near the chin.

Second vertex, R.O.A.

The occiput lies to the right and in front. In its internal rotation it travels along the anterior part of the right side of the pelvis to reach the middle line. Extension takes place as above. The shoulders enter in the right oblique diameter of the pelvis. When the head is free the occiput turns towards the mother's right thigh. The left shoulder rotates to the front, and the head makes a further rotation with the occiput towards the mother's right thigh.

Third and fourth vertex, R.O.P. and L.O.P.

The mechanism in the occipito-posterior positions depends on whether
1. The head is well flexed; or
2. The head is incompletely flexed.

The head is well flexed

Mechanism. If the head is well flexed the occiput is in advance when the head meets the resistance of the pelvic floor. To escape from this resistance the occiput makes a long rotation, through three-eighths of a circle, to reach the free space under the pubic arch.

In the *third position* the occiput lies behind and to the right. It rotates along the right side of the pelvis to reach the front, the shoulders rotating with it from the left oblique diameter of the pelvis into the right oblique. From this point the mechanism is the same as that of the second vertex position.

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In the *fourth position* the occiput makes a long rotation along the left side of the pelvis. The occiput rotates towards the mother's left thigh as soon as the head is born, the right shoulder comes to the front, the final stages being just the same as when the head lies in the first position.

When asked why some cases of occipito-posterior positions cause difficulty, many students reply that the reason is that the occiput has to make a long rotation and that, therefore, labour is prolonged. This is not correct. If the head is fully flexed, as it must be for the long rotation to occur, there is no delay in the labour and no difficulty. The cause of difficulty is that in some cases flexion is incomplete, and, therefore, the normal long rotation does not occur.

The head is incompletely flexed

In some cases flexion is incomplete when the head lies in the third or fourth position. There are two reasons for this incomplete flexion:

(*a*) When the back of the fœtus lies against the front of the uterus, with the spine flexed, the concavity of the fœtal body fits the convexity of the maternal spine. The tighter the abdominal muscles of the mother the more complete will flexion be. When, however, the back of the fœtus lies against the maternal spine the two convexities are in contact with one another. The fœtal spine has then a tendency to become less completely flexed, so as to fit the maternal convexity better. This causes some extension of the head.

(*b*) When the occiput lies to the front, with the sagittal suture in one of the oblique diameters of the pelvis, the biparietal diameter, the largest transverse diameter of the head, lies in the other oblique diameter. When the occiput occupies the posterior part of one of the oblique diameters the biparietal diameter does not lie in the other oblique, but in a smaller diameter (the sacro-cotyloid), which is encroached on by the promontory of the sacrum. When the head is pressed down into the pelvis in this position, the biparietal diameter is hindered from descending if the pelvis is small or the head large, and so the forepart of the head descends more easily than the occiput, and the head enters the pelvis incompletely flexed. While the head is above the brim extension may go on until a face presentation is produced, but if a normal sized head enters the pelvis incompletely flexed further extension is impossible, as this would cause a still larger diameter to engage in the pelvis, and the size of the pelvis would not allow this to occur.

If flexion is incomplete the occipito-frontal diameter of the head, which measures 11·4 cm. (4½ inches), has to pass through the pelvis, instead of the suboccipito-frontal, which measures 10·2 cm. (4 inches), or the sub-occipito-bregmatic, which measures 9·5 cm. (3¾ inches). It is this and the fact that, sometimes, neither the occiput nor the forehead is sufficiently

in advance to influence rotation that explain why some cases of occipito-posterior positions cause difficult and prolonged labour.

Mechanism in occipito-posterior positions with incomplete flexion. When the head is pressed down on to the pelvic floor the occiput is not the lowest part of the head, not having descended so much as it would have done if flexion were complete.

The forehead is now as low as the occiput, and being at the anterior end of the oblique diameter of the pelvis, meets the resistance of the pelvic floor before the occiput. The forehead, therefore, goes to the front, to the free space under the pubic arch, rotating through one-eighth of a circle, while the occiput makes a short rotation backwards into the hollow of the sacrum. It is important for the student to understand why the occiput rotates into the hollow of the sacrum. The occiput goes to the back simply because the forehead goes to the front, the forehead being the important factor in the internal rotation because it is lower than the occiput, and, therefore, meets the resistance of the pelvic floor first. If the head is normal it may be born with face towards the posterior surface of the symphysis pubis. The root of the child's nose is pressed against the bone and becomes fixed, and the head rotates about this fixed point. The vertex is born by flexion and followed by the occiput. As soon as the occiput is born the head extends, the face and chin emerging from under the pubic arch. The vulval orifice is stretched by the occipito-frontal instead of the sub-occipito-frontal diameter with a difference in size of 2 cm. ($\frac{3}{4}$ inch), and a severe perineal tear may occur.

In some cases the head becomes arrested with its long axis in the transverse diameter of the pelvis, the degree of extension being such that neither the occiput nor the forehead is sufficiently in advance to influence rotation. This is described as *deep transverse arrest* of the head and calls for interference, which will be described later. Some of these cases are the result of incomplete forward rotation from an occipito-posterior position. Other cases, perhaps the majority, are the result of descent of a head which originally lay in the occipito-transverse position and which has failed to rotate anteriorly.

MANAGEMENT OF LABOUR

THE majority of patients nowadays are confined in hospital. As soon as the patient is admitted, her antenatal record should be reviewed to discover whether there have been any abnormal features during pregnancy, and she should be examined to confirm that the presentation remains satisfactory. Rarely the patient will not have had any antenatal supervision. In this case a complete examination will be necessary.

If the patient is to be delivered in her own home the doctor should go to see the patient as soon as labour begins. In domiciliary cases a supply of sterile towels, dressings, antiseptics, etc., will generally have been arranged by the nurse, but the doctor should check that everything necessary is present.

Asepsis. Although the dangers of infection have been much reduced by the use of antibiotics, it is still very important to minimize the risk of introducing infection to the genital tract during labour and the puerperium. Full sterile precautions along operating theatre lines should be taken by those delivering the patient and by any other persons present in the labour room. Vaginal examinations should be limited as far as possible.

Arrangement of the lying-in room and the bed. The room should be cleared of all unnecessary furniture, so as to leave ample room for a table for instruments and dressings, a small table for the anæsthetist and a table for basins and lotions. The room should be warm and a good light in a position most suitable for the accoucheur is absolutely necessary. A single bed, if it is possible of a height of 3 feet, should always be used for the confinement, as it facilitates the management of the mother during the labour and the nursing of her afterwards. A fairly unyielding mattress is necessary for the labour; any sagging of the bed tends to make delivery more difficult for the accoucheur. A mackintosh sheet is laid over the mattress, then a blanket and bedsheet with a second mackintosh sheet or batiste over these. The upper mackintosh should overhang the side of the bed on which delivery will be effected, so that blood or liquor can drain into a receiver below. A large sterile pad of absorbent wool, such as Gamgee tissue, should be placed immediately under the mother's hips and changed when necessary.

The patient's dress. The best costume consists of a nightgown, long woollen stockings and a bed-jacket. During the second and third stages

the nightgown is pinned up towards the armpits and so kept clean and out of the way. The vulva, thighs and buttocks should be covered with sterile towels.

Examination of the patient. By abdominal palpation and auscultation the presentation and position are diagnosed, and also the relation of the presenting part to the brim of the pelvis—whether it has entered or is still above it. If the presenting part has not yet entered the brim, an attempt must be made to find out whether or not it can be made to enter. In the majority of patients it is only a matter of confirming facts which had been made out and recorded in the antenatal period. The doctor makes a pelvic examination to investigate the size of the os, and then decides from the degree of dilatation, the strength and frequency of pains, and the fact that the bag of membranes is still unruptured or not, whether he must stay or can safely leave the patient temporarily. Only experience and judgment of each case on its merits, will teach the student when he can safely leave. If the os is not more than half dilated in a primipara and there are no unusual features about the case, he can go away for a time; but it is not safe to leave a multipara at this stage. It is far better for the patient's safety and for the doctor's reputation that he should stay for some hours unnecessarily than that he should be away when the child is born. If the patient is nervous, especially in a first labour, the doctor should not stay in her room all the time, but remain near at hand.

Management of the first stage

When the first stage is commencing an enema of soap and water should be given. The patient may have a hot bath, after which the vulva and surrounding skin are thoroughly cleansed and shaved.

If an expectant mother is given some idea in simple language of what to expect in each stage, a great deal of the apprehension from which so many women suffer can be removed before labour begins. If she is told that the first stage is the long one, and one in which she herself is not likely to appreciate much progress, it will be much more easy to reassure her and maintain her patience once labour has started. It is unwise to forecast the probable duration of the labour.

If the head has engaged there is no need for the patient to stay in bed; there is a distinct advantage in her walking about, resting on a chair or sofa when necessary. The weight of the liquor amnii and fœtus helps in the dilatation of the cervix, and the pressure on the lower uterine segment and cervix stimulates the uterus to contract. During the first stage the patient is not usually conscious of any progress, and is more likely to be discouraged, nervous, fractious, and clamorous for assistance or relief if

she is kept lying down than if she is allowed to walk about. In cases in which the presenting part is not engaged the patient must be kept in bed during the first stage to diminish the likelihood of early rupture of the membranes.

The pain during the early part of the first stage of labour is usually not very severe, though in primiparæ it may cause a good deal of distress. Towards the end of the first stage the pains may become very distressing
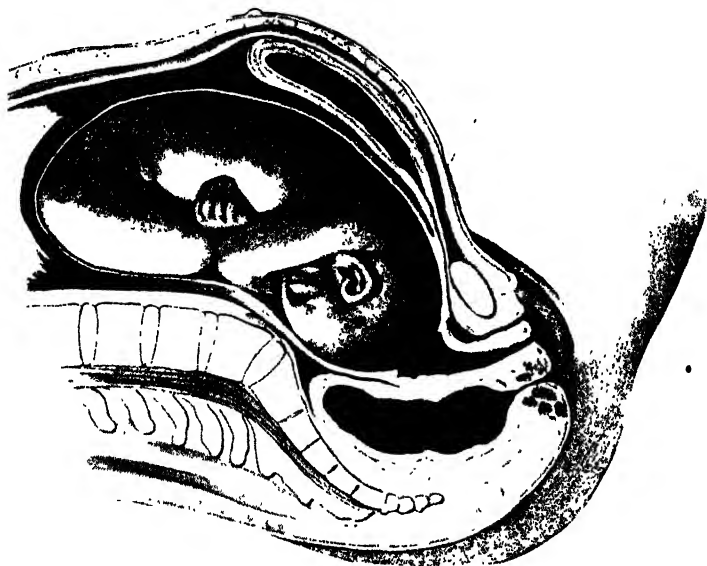
FIG. 67.   Full bladder during labour.

and the patient may sometimes vomit at this time. Analgesic drugs such as pethidine may be given when the cervix is two-fifths dilated, but a patient who has been intelligently prepared for labour may be allowed to decide for herself when she needs the first dose. The fact that the drug is available gives her confidence and she may prefer to defer its use. It is wrong to tell a woman to bear down during this stage. Bearing down before the dilatation of the os is complete is useless, and the patient's strength is exhausted by such fruitless efforts. Many women experience a feeling of relief and comfort when the lower part of the back is pressed on or rubbed during a pain.

There is usually a frequent desire to pass water during this stage. If the bladder becomes full and the patient cannot empty it, a soft catheter must be passed, as a full bladder has an inhibiting effect on the uterine contractions.

During labour patients should only be given fluids or sieved foods as there is always the possibility that the patient may need a general anæsthetic towards the end of labour, and it is better to withhold food so as to reduce the risk of vomiting during induction of anæsthesia and the resultant risk of inhalation asphyxia.

The administration of a mixture of trilene and air or of nitrous oxide and oxygen with the onset of each contraction may be begun towards the end of the first stage, and may greatly assist the patient's expulsive efforts in the second stage.

Management of the second stage

During the second stage the patient should be in bed, and the nurse or medical practitioner should stay with her. During this stage it does not matter in what position the patient lies. Some seem to be able to use their voluntary muscles better if they are lying on their backs with the knees drawn up. Others prefer to lie on one or other side drawing the knees up as the contraction begins. If the second stage is prolonged it may be necessary to pass a catheter if the patient cannot pass urine. When the head begins to show at the vulva it must be decided whether the patient is to be delivered on her back or on her side. In domiciliary practice where little help is available the left lateral position is probably the better and most obstetricians consider that it is easier to control the birth of the head in this position. In hospital practice where plenty of assistance is usually available most patients are delivered on their backs. It is easier to maintain a good aseptic technique in this position and in many patients the uterine contractions seem to be better sustained.

As each uterine contraction develops and pushes the head on to the pelvic floor the expulsive reflex will be stimulated and the patient will generally take a deep breath, hold it, and strain down. In a first labour it may be helpful to give the patient a little instruction at this stage and she should be encouraged to relax the muscles of the pelvic floor at the time of the contraction.

The progress of the descent of the head can generally be judged by watching the perineal region. At first there will be a slight general bulge of the perineum as the patient strains. As soon as the head is on the perineum the anus will begin to open with each contraction and soon after this, the caput will be seen at the vulva at the height of each contraction. Between each contraction the elastic tone of the pelvic muscles will return the head to the cavity of the pelvis.

With each contraction the vulval outlet and whole perineal body will become more and more stretched until the head is so low that the occiput can begin to slip forwards under the pubic arch. The head is now said to

be crowned and it will no longer go back when the contraction passes off, and delivery is imminent.

Care of the perineum. If the contractions are strong and delivery is left entirely to nature, laceration of the perineum may be caused during the birth of the head. A tear of the fourchette in a primipara is sometimes called an inevitable laceration, but even this is not absolutely inevitable. A tear of the perineum begins, as a rule, in the posterior vaginal wall, and if the perineum is distended further the skin will begin to tear. Even when the head is delivered without laceration, the birth of the shoulders may damage the perineum, and if the head has produced a small laceration the birth of the shoulders is likely to increase the damage.

The management of the delivery of the head may be summed up under the following headings:

1. Do not let the head be born too quickly.
2. Keep the head flexed until the occiput has escaped under the pubic arch.
3. If possible, do not let the head be born at the height of a contraction.

As soon as the head begins to appear at the vulva, some degree of anæsthesia is generally desirable. In domiciliary practice a trilene inhaler is generally effective, but it is a great advantage to have an anæsthetist present, so that he can deepen the degree of anæsthesia towards the end of delivery if necessary.

The head will be seen to show at the vulva with each contraction of the uterus, and will disappear between pains. Gradually the amount showing will increase until eventually the head does not return when the uterus relaxes. This indicates that the greatest diameter of the head has now passed under the symphysis pubis and through the pelvic floor; the head is now said to be crowned.

During this stage the accoucheur should be ready to control the head if he thinks there is any risk of its being born suddenly, and to keep it flexed until the largest diameter has passed the outlet. Once the head is crowned the patient should be prevented from bearing down by deepening the anæsthesia if possible, or by encouraging her to breathe deeply or cry out if she is still conscious. The head may now be delivered carefully by making pressure on the fore part of the head by a finger on either side of the rectum, pushing the head forwards slowly, easing the sides of the vulval orifice over the parietal eminences before the head is allowed to extend and complete its delivery. As a rule, the head can be coaxed out in this way with the minimal amount of laceration of the maternal tissues (Fig. 68).

If extension of the head begins before the occiput is free under the pubic arch and before the biparietal diameter has passed through the vulval orifice, a larger diameter than the suboccipito-frontal will distend the vulva

and a tear may result. The fact that the head has become crowned gradually does not ensure freedom from perineal rupture should the head be expelled suddenly and rapidly. It is very important that the head should be born gradually and in the interval between pains.
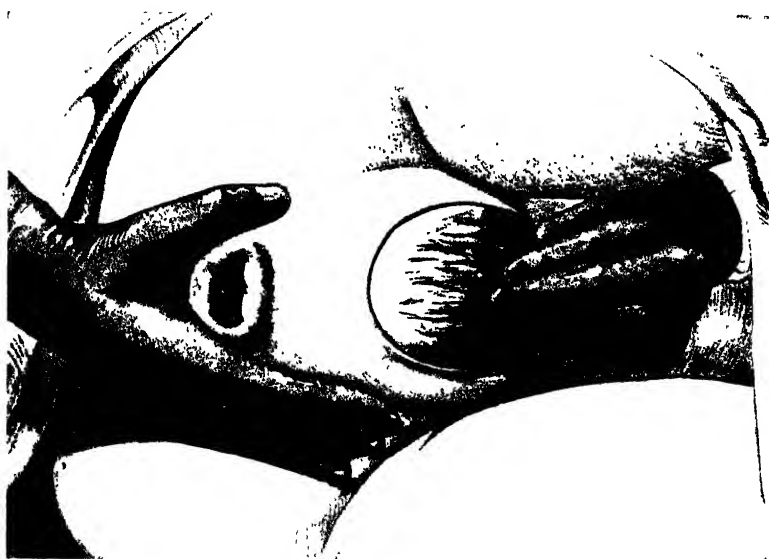
FIG. 68.   Care of the perineum.

The left hand is preventing sudden expulsion of the head, while the fingers and thumb of the right hand are gently helping the head forwards by pressure on each side of the anus. This pressure is exerted in an interval between the pains. Towels have been omitted for the sake of clarity, but the right hand would be protected from anal contamination by using a towel or pad.

It is quite useless for the accoucheur to attempt to hold the head back against the whole strength of the mother, and attempts to do so may cause an intracranial injury to the fœtus. Pressing the head forwards too forcibly may injure the anterior part of the vulva, bruising the urethra against the symphysis pubis, and may even cause severe hæmorrhage from the vascular tissues round the clitoris. In patients in whom the head has emerged without causing laceration of the perineum, a tear may occur during birth of the shoulders.

Episiotomy, or incision of the perineal body is to be advised in certain cases (See p. 548.) and a clean incision is always preferable to an irregular laceration.

The posterior vaginal wall and perineum must always be examined carefully after the end of the second stage, and any laceration beyond the

most trifling repaired by sutures. This examination can be made only after widely separating the labia in a good light, with the patient on her back. It is far more blameworthy to neglect a tear than to allow it to occur.

Completion of delivery. Directly the head is born a finger is inserted to feel whether a loop of cord is round the neck or not. If it is, the loop should be slipped over the head, or if this cannot be done, over the shoulders. If the loop cannot be slipped either way, the cord should be clamped with two pairs of artery forceps and divided between them.

The shoulders usually follow with the next pain after the birth of the head, the anterior shoulder being allowed to be born before the posterior. The perineum may be torn if both shoulders are allowed to be born simultaneously.

The rest of the body quickly follows, the right hand guiding the child forwards and laying it on the bed while the left hand follows the uterus down.

As soon as the child is delivered it should be held with its head downwards so that any mucus or liquor in the mouth or pharynx may run out. The mouth and pharynx should be sucked clear with a mucus extractor. A healthy baby breathes very soon after it is born, if it fails to do so, it should be treated as directed on p. 635.

Extraction of the shoulders. If the shoulders do not descend after the birth of the head, the mother should be exhorted to bear down. If the shoulders still do not move, and the child's face is getting blue, their birth must be assisted. If the shoulders have not rotated into the antero-posterior diameter they must be rotated by digital pressure. If there is still delay after rotation of the shoulders attempts must be made to free the anterior shoulder by flexing the head laterally, towards the anus. Once the anterior shoulder has come past the symphysis the posterior can usually be delivered easily by pulling the head forwards so that the posterior shoulder does not injure the perineum. As little force as possible should be used in this manœuvre, for injury to the cervical nerves and sterno-mastoid muscle may result if undue force is used. The amount of force necessary can be reduced by asking the mother to bear down or, if she can no longer co-operate, by getting an assistant to push on the fundus of the uterus at the same time. If this fails it may be necessary to make traction in the axilla but this carries the risk of injury to the brachial plexus.

Moulding of the head in vertex delivery. In occipito-anterior positions the greatest squeeze is exerted on the suboccipito-frontal diameter,

consequently this diameter is diminished while the diameter at right angles to it, viz. the vertico-mental, is increased in size, and the head is elongated in an upward and backward direction.

FIG. 69. Moulding of the head in occipito-anterior positions. The dotted outline shows the shape of the head before moulding. The sub-occipito-frontal or suboccipito-bregmatic diameter is compressed, while the mento-vertical diameter is increased in length.

Separation of the child. The cord should not be clamped until the child has cried vigorously, the pulsation has ceased except in the last few inches from the umbilicus, and the umbilical vein has collapsed. If it is clamped immediately, the child is deprived of 60 or 90 ml. (2 or 3 ounces) of blood which should have been drawn out of the placenta by the expansion of the lungs. This volume represents the same proportion of the total blood volume of the infant as 1·5 litres would be in an adult. The importance of waiting a few minutes before tying the cord is evident and there is something to be said for holding the baby below the level of the placenta during this time so that blood may flow into the baby by the force of gravity. The cord should be tied about 7·5 cm. (3 inches) from the umbilicus, a reef-knot being used and care being taken that the umbilicus is not pulled on during the tying of the ligature. It is not necessary to tie a second ligature except in the case of twins (Chapter 25), but a second ligature or clamp will prevent the escape of placental blood into the bed. The ligature generally consists of three or four strands of packthread tied into a knot at each end. It should be boiled and left in the boiled water or some antiseptic solution until wanted.

Small plastic crushing clamps are now available. The clamp is very light and can be left on the cord. It has the advantage that it gives continuous pressure and if the cord shrinks the clamp does not become loose.

Management of the third stage

The third stage of labour is a natural and physiological process; in a normal delivery the uterus will generally rest for a few minutes after the delivery of the baby. Regular contractions of the uterus soon begin again, and a few contractions will suffice to separate the placenta from its attachment to the uterine wall and push it into the vagina. The mother will
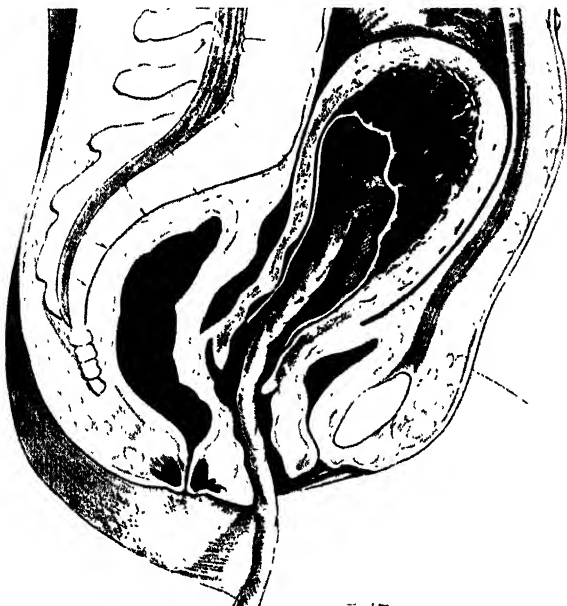
FIG. 70.   Third stage of labour.
The placenta is still in the uterus.

become aware of its presence on the pelvic floor, and by straining, expel it through the vulva. While the placenta is separating there may be a slight trickle of blood and a few ounces of blood will be expelled with the placenta but the total amount lost should not exceed 300 ml. (10 ounces).

Signs which show that the placenta has been expelled into the vagina

1. The cord moves down. This sign is most to be relied upon if a ligature has been tied close to the vulva after the slack of the cord has been

pulled out of the vagina. In a case of doubt the fundus may be gently pushed down. If the extra length of cord expressed does not return on letting the fundus rise again, the placenta has separated.

2. The uterus rises up, and feels smaller, harder, rounder and more movable. It is now perched on the placenta, and so the fundus reaches to the level of or just above the umbilicus.

3. There is frequently a little gush of blood when the placenta leaves the uterus.

The danger of this stage of labour is that the amount of blood lost may be excessive. If the blood runs out of the vulva it will, of course, be immediately apparent. Sometimes, however, the blood may remain in the uterus distending it, or in the vagina pushing the uterus upwards, and the patient may lose a dangerous amount before it is obvious to an unskilled observer.

The third stage of labour is a natural process which may be managed by simple observation and with avoidance of any interference unless delay or bleeding occurs. When the placenta has separated naturally and been expelled through the cervix it may be delivered by maternal effort or with minimal assistance from the obstetrician. This may be described as the conservative or passive method of management of the third stage.

Many obstetricians advocate an alternative and more active method in which an oxytocic drug is injected at the time of delivery of the shoulders of the fœtus, so that the uterus contracts strongly and immediate placental separation occurs. If this active method is followed the placenta must be delivered immediately from the uterus, otherwise the unusually strong contraction of the uterus may cause placental retention in the lower segment.

In the first or passive method the placenta may be expelled from the vagina (1) by the mother bearing down, (2) by the obstetrician pressing on the fundus of the contracted uterus, (3) by cord traction, or (4) by Brandt-Andrews method (see below).

In the active method the obstetrician must expel the placenta from the uterus as soon as strong contraction occurs.

We may now give details of these methods. The student may find that one or other policy is followed in his school. It is important to grasp the principles involved, and not to confuse the purpose of the two methods.

Conservative method

In a normal case the management of the third stage is concerned wholly with observing that the separation and expulsion of the placenta is following a physiological course and that bleeding is not excessive.

It is most important that nothing should be done to interfere with the

normal action of the uterus. If it is prematurely stimulated to contract, the placenta may be partially separated, and excessive bleeding will result. It is essential, however, that the technique adopted shall ensure that no appreciable amount of blood shall accumulate in the uterus or vagina.

The third stage is best conducted with the mother lying on her back. In the most commonly used technique, the left hand is laid gently on

Navel.
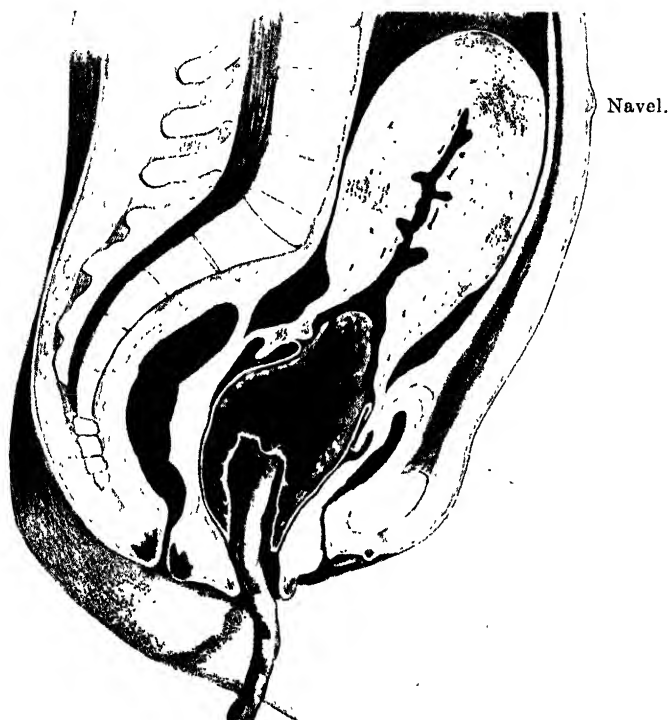
Fig. 71.　Third stage of labour.
The placenta has been expelled into the vagina, and the uterus, perched on the placenta, has risen to a higher level than it reaches in Fig. 70.

the abdomen so that the upper limit of the uterus can just be felt. After a few minutes the uterus will be felt to contract, and relax again. When the placenta leaves the uterus and passes into the vagina, the uterus will be felt to become smaller and rounder, and the fundus will rise to the level of the umbilicus. If the uterus or the vagina is becoming distended with blood, the fundus will begin to rise, and the treatment advised for postpartum hæmorrhage should be given (Chapter 36).

As there is some risk of prematurely stimulating the uterus by placing a hand on the fundus, in some clinics the third stage is conducted by

observation alone without placing the hand on the fundus. In a thin patient it is quite easy to see the level of the fundus, to observe the contractions of the uterus and to watch it rise up as the placenta is expelled into the vagina. If bleeding is occurring the increase in the size of the uterus can also be observed. If, however, the patient is obese, it is difficult or impossible to observe the size of the uterus with accuracy, especially when contractions are absent.
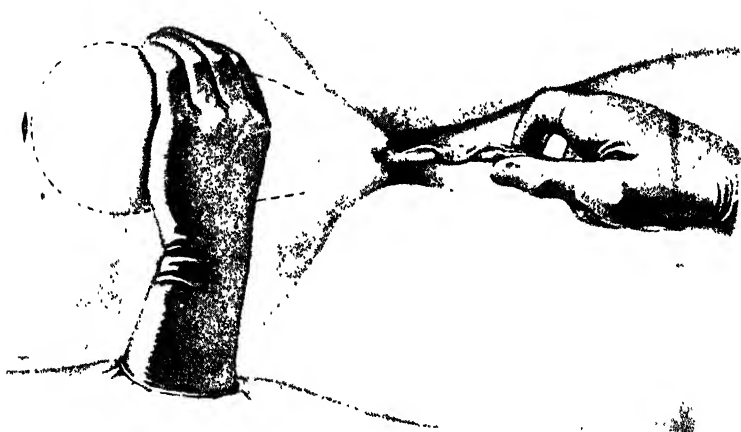
Brandt-Andrews method of delivery of the placenta.

FIG. 72.

Now is the time for expulsion. When the uterus contracts again the patient should be encouraged to bear down and she will generally be able to expel the placenta herself. If she fails to do so the accoucheur grasps the uterus with his left hand, and waits for a contraction; then using the contracted uterus as a plunger to expel the placenta from the vagina, he presses it downwards and backwards gently and steadily. As the placenta comes out of the vulva it is received in the right hand, and gently drawn away from the mother. In some clinics traction on the cord is advocated as an alternative method of assisting at this stage. Providing the uterus is contracting and the placenta lies in the vagina this is a good method.

The objection to this method is that if the placenta is in the relaxed uterus, traction may cause acute inversion of the uterus, and experience shows that it is not always easy to be sure that the placenta is in fact in the vagina. If the third stage has been left to nature, the membranes generally slip out after the placenta. If, however, they do not come away with gentle traction on the placenta, they should be taken between the finger and thumb and very gently pulled. The last parts to be separated then glide out. The left hand must still be kept on the uterus until it is certain that it is well retracted and not inclined to bleed. At the end of the third stage of labour,

Fig. 73.   The end of the third stage of labour.
The uterus is empty, contracted and retracted, and lies at a much lower level in the abdomen owing to the collapse of the lower uterine segment.
[Diagrammatic]

when the uterus is empty and retracted, the fundus reaches halfway between the umbilicus and the pubes (Fig. 73). A few hours later the fundus reaches 14 cm. ($5\frac{1}{4}$ inches) above the pubes owing to the recovery of the pelvic floor and of the tone of the lower uterine segment which follows labour.

Brandt-Andrews method. This method was described by Brandt in 1933 and rediscovered by Andrews in 1940. It has been adopted in many units as the standard method of management of the third stage. After waiting for a few minutes following the birth of the child, with the patient lying on her back, the obstetrician places his left hand with the palmar

surfaces of the fingers over the anterior surface of the uterus just above the symphysis pubis, at the presumed level of the junction of the upper and lower uterine segments. Artery forceps are placed on the umbilical cord, which is held just taut, but without strong traction, with the right hand. The uterus is now lifted up with the left hand and if this can be done satisfactorily it means that the placenta is below the level of the lifting hand and is in either the lower segment or the vagina. Lifting is now discontinued and pressure made with the same hand in a downward direction until the placenta is seen at the introitus. After the placenta has been expelled the uterus is lifted out of the pelvis to decrease the tendency to hæmorrhage.

It will be noted that the principle of the method is not one of cord traction but rather of elevation of the uterus, which goes far to prevent acute inversion of the uterus as a complication.

Active method

In 1935 an efficient and non-toxic oxytocic drug, *ergometrine*, became available. It was first used for the treatment of postpartum hæmorrhage after the uterus had been emptied, but soon after its introduction it was used experimentally to achieve delivery of the placenta. It has now been shown in many maternity units that by giving ergot at the time of the birth of the baby or immediately after its birth, the amount of blood lost in the third stage is reduced and there is much less risk of postpartum hæmorrhage. Ergot produces a prolonged contraction of the uterus and cervix without periods of relaxation, so there is some risk that the placenta may be grasped in the uterus or cervix before it can be expelled to the vagina. While the uterus is contracting there is not likely to be any excessive bleeding, but there is no doubt that giving ergot before the placenta has left the uterus slightly increases the number of cases in which manual removal of the placenta becomes necessary. This disadvantage is slight compared to the advantage of the reduction in the incidence of postpartum hæmorrhage. Manual removal performed by a skilled obstetrician, under good conditions, with a skilled anæsthetist, is associated with very little risk, although under less satisfactory conditions it can be a dangerous procedure.

Opinions differ as to when the ergot should be given. The usual method is to inject 0·5 mg. intravenously as soon as the anterior shoulder of the fœtus has safely passed under the subpubic arch. Immediately the fœtus has been delivered and the cord clamped the obstetrician places his left hand on the uterine fundus, and directly a strong contraction is observed the placenta is delivered by a combination of fundal pressure and cord traction, or by the Brandt-Andrews method. It is wrong to await signs of

separation or delay in delivery of the placenta. The placenta nearly always separates with the first contraction and delay increases the risk of its retention. This method of course implies that someone must be able to give the intravenous injection, and for that reason it is hardly suitable for the midwife working alone.

Alternatively the ergometrine may be injected intramuscularly. Since the drug takes 7 minutes to act by this route there seems to be little or no advantage in this method over the conservative management. Even if the drug is combined with hyaluronidase to speed up its absorption it takes over 4 minutes to act effectively.

A new combination, Syntometrine, contains 0·5 mg. of ergometrine and 5 units of Syntocinon per ml. It is claimed that if this mixture is given intramuscularly the Syntocinon will act fairly quickly (although not so fast as intravenous ergometrine) and maintain its action for about 20 minutes. The ergometrine will be effective after about 7 minutes, by which time the placenta will have been delivered, and then maintain uterine contraction for over an hour.

In domestic practice if the placenta is retained after giving ergot, providing there is no bleeding there is usually plenty of time to send for the flying squad. It is generally not safe to transfer the patient to hospital as there is some risk that severe bleeding may begin at any time. If the patient must tbe transferred to hospital because no help is available then the practitioner should go with her in the ambulance.

Examination of the perineum. After the placenta is delivered the vulval outlet must be examined carefully for lacerations. They are a source of danger during the puerperium, so any laceration more than a minute one must be sutured as described on page 441.

Vaginal and vulval lacerations seldom cause much bleeding unless they involve the tissues round the clitoris or varicose veins, when the bleeding may be severe.

Examination of the placenta and membranes. The placenta and membranes must always be thoroughly examined as soon as possible. If the membranes have been inverted during birth, so that the amnion is on the outer side, as commonly happens, the placenta must be gently pushed out through the hole in the membranes, so that its maternal surface can be examined. This is best done by placing the placenta on the palms of both hands, maternal surface upwards. If there is much adherent clot it should be removed. The maternal surface will be seen to be marked by numerous furrows, or sulci, dividing the placenta into lobes. When the surface is made roughly concave, all these lobes should fit into one another. If the placenta is torn, but complete, it will be seen that the sides of the

tear meet without any tissue being missing. If, however, any part is missing, a gap will be seen which cannot be filled up completely by making the surface concave.

Having examined the maternal surface of the placenta, the next step is to examine the membranes. These should form a bag, complete except for the hole through which the child passed. The amnion and chorion should be gently separated from one another, and each examined separately. Some care is generally necessary in doing this until the edge of the placenta is reached, but the amnion can be easily separated from the placenta right up to the insertion of the cord.

The amnion is a tough, thick, translucent membrane. A portion of it is not likely to be retained, because it is not attached to the uterus. The chorion, on the other hand, is attached to the decidua, and so it is not uncommon for portions of it to remain behind. The chorion, when separated from the amnion, is found to be friable and is not translucent. On its uterine surface are seen fragments of soft reddish tissue, the decidua. It should form a bag, and should be attached all round to the edge of the placenta. If chorion is missing from any part of it, a careful search must be made to ascertain whether the membrane has simply been torn at this point, or whether part of it has been torn off and retained in the uterus.

A more important condition is that in which two blood-vessels, an artery and a vein, run off the edge of the placenta, going to a small detached island of placental tissue called a succenturiate placenta. If this has come away, together with the main placenta, it will be plainly seen. If it is retained, there must be a hole in the chorion corresponding to it, and a pair of vessels torn through at the edge of the hole. Succenturiate placentæ are not very common, but the possibility of their occurrence should never be forgotten in an examination of the placenta, as a careless examination would fail to reveal the fact that such an island of placental tissue had been retained. They are found most commonly in association with cases of placenta prævia.

The reason why such a careful examination is important is that if a piece of placenta is retained it may cause postpartum hæmorrhage, subsequently causing subinvolution of the uterus and sepsis. If, however, a piece of membrane is retained within the uterus, be it large or small, amnion or chorion, or both, it will not cause any complications and will be expelled by uterine contractions within 2 or days. It is never necessary to explore the uterus to remove a piece of membrane.

THE PUERPERIUM

THE puerperium is the time following labour during which the pelvic organs return approximately to their condition before pregnancy. Some of the anatomical features of nulliparity are never recovered as a result of the normal changes during pregnancy and labour. The puerperium may be said to extend over 6 to 8 weeks though no exact time limit can be set.

The management of the early puerperium consists in keeping careful watch upon the physiological processes during this time, and in being prepared to intervene early and effectively if they should show signs of becoming pathological.

The most important considerations in the management of the puerperium are:

1. Attention to the proper feeding, rest, and general mental and physical welfare of the mother.
2. Prevention of septic infection.
3. Conscientious observation of the temperature, pulse-rate and progress of involution.
4. Care of the breasts, and the promotion of lactation.
5. Exercises designed to restore the tone of the abdominal wall and pelvic floor.

Prevention of septic infection. Every precaution should be taken to prevent the implantation of exogenous pathogenic organisms into the birth-canal during labour and in the peurperium. Manipulations involving the exposure of the vulva and perineum should only be undertaken by those who are themselves free from infection, are wearing masks and have sterilized their hands. During delivery the vulva and surrounding skin are swabbed with an antiseptic solution or cream, such as one containing $2\frac{1}{2}$ per cent hibitane. In the puerperium the vulva and perineum should be kept clean and dry. Provided there is no rise in temperature the patient may leave her bed to visit the lavatory and may have a shower or sitting bath on the 2nd day after delivery. There is no need for swabbing the vulva or for pouring antiseptic solution over it after delivery or in the puerperium.

Between whiles the vulva must be kept covered with a dry sterile pad, which must be renewed by the nurse with surgically clean hands whenever it is soaked or soiled. The pads are secured with a T-bandage, which must also be frequently renewed. Dry sterilized dressings are now supplied in air-tight cartons at a nominal cost by nearly all the Local Health Authorities.

During the changing of vulval pads, the nurse should wear an efficient spray-proof mask.

Relatives, nurses, students and doctors who have septic foci themselves, or may carry an infection from recent contact with septic conditions or attendance at post-mortem examinations, must be excluded from all labour and lying-in wards. Efficient masks must also be worn by doctors when making vulval or vaginal inspection for the first ten days after delivery. Suspect cases, i.e. those in whom the puerperium for various reasons involves an extra risk of sepsis, however slight that risk may be, should be nursed in separate wards, and patients unexpectedly developing signs indicative of sepsis should be at once isolated from the normal cases.

In order to reduce the risk of infection spreading, modern maternity units are designed so as to contain small wards of four to six beds. Ventilation should be by a positive pressure system so that pure fresh air is introduced into the ward rather than by extractor fans which suck infected air from other parts of the hospital. Many organisms, in particular *Staphylococcus aureus* and the hæmolytic streptococcus, are found in dust and in blankets. Only wet-dusting should be permitted in a maternity ward and exposure of the vulva allowed only when the dust has had time to settle. Single rooms should be provided for suspect cases, and an' isolation block made available in a building separate from the main maternity ward for infected patients.

Time of getting up. There is no doubt that after the physical and mental strain of pregnancy and labour, a patient needs a period of rest from hard work and mental worry of at least 14 days.

Providing the labour has been normal, and there has been no gross injury to the pelvic floor or other complications, there is no need for the patient to spend the whole of this time in bed. In primitive races the mother leads a normal life immediately after delivery. Until recently the custom in this country was to keep the patient in bed for 10 to 14 days to allow most of the involution of the uterus to be completed before any weight was thrown on the stretched pelvic diaphragm. The present tendency is to allow the patient out of bed for short periods from the day after delivery, but to keep her activities limited in hospital or at home until the 10th day. Early ambulation must not be made an excuse for shortening the total time of convalescence.

This period of relief from hard work and domestic worries will allow time for breast feeding to be comfortably established, and the slight amount of exercise which the patient is allowed to take will prevent her from becoming debilitated by prolonged rest in bed. The evidence suggests that the involution of the uterus and the recovery of the tone of the pelvic diaphragm are both improved by this system; the circulation is improved

in the lower limbs and the incidence of venous thrombosis reduced. In abnormal cases and when there has been severe laceration of the perineum, it may be necessary to keep the patient in bed for a longer time.

Temperature and pulse. The temperature may rise to 100°F for a brief time in the first 24 hours, afterwards falling to normal and remaining so. Such a rise of temperature is called reactionary, and is comparable with that which may occur in other conditions involving prolonged muscular strain.

Any febrile condition occurring in a women in whom a temperature of 100·4°F (38°C) has occurred within 14 days of childbirth or miscarriage is defined as puerperal pyrexia by the Ministry of Health, and is compulsorily notifiable to the Medical Officer of Health by the practitioner attending the case.

It cannot be too strongly emphasized that when the temperature remains raised for more than a few hours, especially if there is a corresponding rise in the pulse-rate, it should be regarded as due to infection arising in the genital tract, until the contrary is proved. The same may be true of a very slight rise, perhaps of not more than 99·5°F, continued for several days, or of a definitely raised pulse-rate without an accompanying rise of temperature. In the Rules of the Central Midwives Board, the midwife is bound to call in a qualified practitioner not only when there is puerperal pyrexia but also 'if the temperature reaches above 99·4°F on 3 successive days'.

For the first few hours after a normal confinement the pulse-rate is likely to be raised but should return to normal by the 2nd day. The pulse-rate should be recorded at the same times as the temperature is taken. A rise in the pulse-rate must be regarded as seriously as is a rise in the temperature. It accurately indicates the general condition of the patient. A raised pulse-rate may indicate severe anæmia, venous thrombosis, infection of the placental site, urinary tract or breast tissue.

Onset of lactation. During pregnancy there is considerable hypertrophy of the glandular tissue of the breasts, but secretion of milk does not start until after the birth of the child. After this time the breasts become more active, and there is increasing vascularity and engorgement. Up to the 3rd day, only a little colostrum is secreted by the breasts. By the 3rd or 4th day the breasts become tense, uncomfortable and tender. The discomfort may be associated with some constitutional disturbance, such as headache, malaise, and slight rise of pulse-rate, but will not as a rule produce any rise of temperature. After this period of engorgement the flow of milk begins. Excessive engorgement of the breasts with milk is dealt with on page 588.

These symptoms are more marked in primiparæ than in multiparæ in whom the flow of milk often starts a little earlier.

All cases of fever during the puerperium should be carefully investigated as described in Chapter 43.

Involution of the uterus. The approximate rate of normal involution is indicated in Fig. 74. Each day following the birth of the child the height of the fundus above the upper border of the symphysis pubis is observed. A full bladder or a loaded bowel will raise the level of the fundus of the uterus and give a false impression of its size. The uterus rapidly diminishes in size for the first week, then more slowly, being completely involuted in
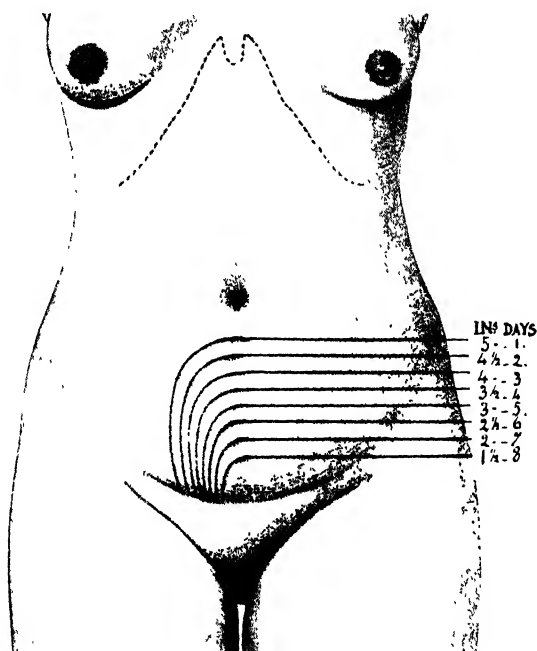
FIG. 74.   Showing normal level of the fundus of the uterus on abdominal examination during the first 8 days of the puerperium.

approximately 8 weeks. At the end of labour the uterus weighs 1 kg. (2 pounds), by the end of the 1st week it loses ½ kg. (1 pound) and during the 2nd week ¼ kg. (½ pound), for the remainder of the puerperium the loss in weight is much slower. By the end of the puerperium it has almost returned to its normal weight of 60 g. (2 ounces). Involution is accomplished by autolysis of the muscle fibres, their protoplasm being broken

down by ferments, liquefied and removed in the blood-stream. The end products are excreted in the urine. Failure of, or delay in, involution is indicative of a local uterine infection, or of retained placental fragments or blood-clot. Involution is also slower when fibroids are present in the uterine wall.

Retention of urine. Most patients are able to pass urine normally after labour. It is no longer considered necessary to swab the vulva after each act of micturition. It is not uncommon for a patient to have a certain amount of difficulty in passing urine for the first day or two after delivery and in a few retention of urine develops. This condition is liable to occur after a difficult labour or when perineal stitches have been inserted. Among the causes of retention are laxity of the abdominal muscles; atony of the bladder; bruising, swelling and tenderness of the urethra or its immediate neighbourhood; reflex spasm or actual pain from perineal lacerations or movement of the pelvis causing traction on the stitches and preventing further expulsive efforts; and the position of the patient on her back. Early ambulation for toilet purposes is often helpful.

The laxity of the abdominal muscles and the atonic bladder wall may permit the distension of the bladder to reach a degree beyond that which usually excites the reflex arc, so that the desire to empty the bladder is not aroused. When the bladder is over-filled in this way only a small quantity may be passed at a time, not enough to empty the bladder, so that residual urine accumulates and may become infected. Retention with overflow may occur either from complete retention which has not been relieved, or following incomplete emptying with gradual over-distension of the bladder; it is likely to be followed by cystitis.

Routine examination of the abdomen is essential in order to detect retention. If the distension of the bladder is of moderate degree the uterus is pushed upwards, if of greater degree the uterus is obscured and cannot be felt at all. Passage of a catheter in any case will clear up the difficulty. Retention with overflow is the commonest cause of dribbling of urine, a symptom which should always be investigated by catheterization.

If retention occurs or residual urine in some quantity be suspected, the bladder must on no account be allowed to become over-distended because of the frequency with which cystitis follows, and a catheter must be passed with due aseptic precautions and gentleness. Should the bladder have become atonic from over-distension, catheterization may have to be continued at regular intervals for days, or a self-retaining catheter inserted.

Incontinence of urine. False incontinence or incontinence with overflow is the result of retention with damage to the sphincter mechanism and temporary loss of control.

True incontinence results from a vesico-vaginal fistula due either to a tear involving the bladder from instrumental delivery, or due to pressure on the soft parts from long labour and later the formation of a slough extending into the bladder. In the latter case it does not generally appear until some days after labour.

Stress incontinence or inability to hold the water on straining is not uncommon in late pregnancy and worsens after delivery. It is due to stretching and dislocation of the vesico-urethral junction from its attachments. If it occurs soon after labour, it is usually temporary. Occasionally when it is permanent an operation for the restoration of the supporting mechanism of the vesico-urethral junction will be necessary for its cure. The operation is not advised until many months, and possibly one or two years, have elapsed, because most cases that occur in the puerperium improve in time with the help of active pelvic floor exercises and the return of tone in the pelvic floor musculature.

Cystitis and Pyelonephritis accompanied by severe constitutional symptoms and fever may arise in the first week of the puerperium. They may occur spontaneously from an exacerbation of a chronic coliform infection of the urinary tract after labour or may follow catheterization, or may accompany and be part of a general infection of the genital passages. They are generally due to infection with coliform organisms, streptococci or staphylococci.

Cystitis may be prevented by encouraging the patient to drink adequate amounts of fluid and to empty her bladder at frequent intervals. Retention and residual urine must be overcome by catheterization. Should infection occur it may be treated by an adequate fluid intake, an alkaline mixture containing potassium citrate 4·0 G. (gr. 60) 4-hourly and a course of sulphonamide therapy, e.g. sulphamezathine 1·0 G. to begin and then 0·5 G. 4-hourly until 25 G. have been given.

For details of treatment of pyelonephritis see page 260.

Bowels. The bowels are always somewhat atonic from release of the abdominal pressure and the lax abdominal walls, coupled with the great demands of the breasts for their share of the fluid intake. Laxatives are often needed. Salines should be avoided as they decrease the fluid content of the milk. Almost any other aperient can be used, but those which act on the muscular walls of the bowel are the best. A laxative should be given on the second night; and if that is not effective suppositories or even an enema may also be required. The best laxatives for this purpose are senna (in tablets or granules) or a mixture of liquid paraffin and milk of magnesia. Fluids are given to supply the demands of the milk secretion as well as the bowel movements. Aperients which act effectively on the

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mother often affect the child adversely as they are all in some degree transmitted to the child in the milk.

The lochia. The lochia arise from the large wound left in the uterus following the separation of the placenta. For the first 3 or 4 days of the puerperium the lochia are red in colour. As the wound commences to heal the amount of this discharge begins to decrease, as also does the proportion of red blood therein. The lochia change from red to pink as the amount of blood diminishes, and later become serous.

Although it has commonly been stated that the lochia disappear by the 10th day after the confinement the average time before they become colourless is in fact usually three weeks, and not uncommonly slight reddish-brown discharge may persist for even longer. The lochia often increase when the patient resumes full activity.

Offensive lochia may indicate infection of the genital tract although infection by hæmolytic streptococci is not accompanied by offensive smell.

Lochia which remain red in colour and excessive in amount usually indicate delayed involution which may be associated with the presence of a small portion of placenta or membrane within the uterus, or of fibroids in the uterine wall. Curettage is not required unless there is free bleeding.

Sleep and the avoidance of anxiety. It is important to see that the patient not only gets her proper night's rest free from the possibility of disturbance by the baby, but also that she has a rest in the afternoon. Pain from perineal stitches, hæmorrhoids and distended breasts are common causes of sleeplessness. If she is excitable and sleeping badly, hypnotics, such as quinalbarbitone 0·2 G. (gr. 3), should be given on the first few nights. After that sleeplessness, unless it is habitual, should arouse anxiety as it may be an early sign of the onset of mental disturbance.

Food. The day after a normal delivery the patient should be given a normal diet. During lactation she needs a considerable increase of her intake of proteins and fats to compensate for those secreted in the milk, so that once the flow of milk is established, the fluid intake and the protein in the diet should be increased.

The diet should contain at least a pint of milk daily to supply the necessary vitamins, and when lactation is well established fruit and vegetables should be increased. Vegetables, salads and animal fats are the best sources of vitamins which will be required for the child's nutrition.

Stitches. Night and morning the perineum should be washed with soap and water and dried. A clean dry sterilized dressing is then applied to

the perineum and changed frequently. Unabsorbed stitches may be removed on the 5th or 6th day.

Care of the breasts. At the first antenatal consultation the breasts and nipples should be inspected. If they are normal the patient should be told to wash them with soap and water daily. Applications of spirit are harmful, and lanoline, which is often applied, serves no useful purpose. Should the nipples be flattened or retracted, in addition to the above instructions, she should be shown how to draw out the nipples, which she should do daily to aid suckling. The wearing of shells under the brassière may assist.

During the latter half of pregnancy secretion oozes from the milk-ducts in small quantity and dries on the nipple, where it forms small adherent scales. These will be removed by the daily washing mentioned above. On the other hand, if no preparation is undertaken for lactation the scales may become firmly united to the superficial epithelium and thus leave a partially raw surface when detached. If these crusts are very adherent, they should be softened by applying to the nipples a compress of sterile olive oil for a few hours, and then washing them off with soap and water. Patients who learn to express their breasts before delivery are better able to prevent milk engorgement by manual expression in the puerperium.

During the first 2 or 3 days the breasts secrete colostrum only, but it is important that the baby should be put to the breast in order to stimulate the secretion of milk and to teach it to suck. The colostrum also has some laxative effect on the baby. Since the amount of colostrum is small, the baby should only be put to the breast every 6 hours, and not allowed to remain there more than 5 minutes, as otherwise the baby may continue sucking after the breast is emptied, and thus make the nipple sore. The baby may be put to the breast on the 2nd day 6-hourly, and on the 3rd 4-hourly, and the period of suckling increased a few minutes each day. Before each feed the nipples which have been kept covered with a sterilized dressing, should be bathed with sterile water. In the majority of cases the patient will be more comfortable if the breasts are supported but not bound.

The mother should never be allowed to go to sleep while the baby is sucking for fear of overlying it, and the baby should never sleep while at the breast, because the nipple is likely to become soft and sore by being retained too long in the mouth.

Visits to the patient. The number of visits paid to any patient will depend on her special requirements, but normally it is best to visit daily for the first four days, and then at longer intervals, so that visits cease after the end of the 2nd week. At each visit the nurse's report should be received, if possible before the patient is seen. A chart, on which are recorded the pulse-rate temperature and uterine involution, should be kept. The abdomen should be palpated to discover if the uterus is diminishing

in size as rapidly as it should. The amount and character of the lochia must be investigated. The breasts and nipples should be inspected and inquiry made as to any difficulty in suckling. If the patient is not sleeping well an attempt should be made to find the cause. If a cause cannot be found, mental disturbance should be considered. The behaviour of the bowels and bladder must receive attention.

The chief points to be investigated about the child are whether it takes its feeds well, whether it sleeps well, the condition of the eyes and the umbilical cord, the character of the motions, and the changes in weight.

Postnatal exercises. In most hospitals from the day after delivery patients are given breathing exercises, exercises to stimulate the abdominal and pelvic muscles, and exercises to the legs to encourage the circulation and so reduce the risk of thrombosis. The patient should be encouraged to continue with the abdominal and pelvic floor exercises during the lying-in period and until the final postnatal examination.

Postnatal examination. This should be carried out at the end of the 6th week. At such examinations enquiry should be made as to whether the lochia have ceased, whether the action of the bladder is normal, with particular reference to stress incontinence, whether she suffers from any unusual discomfort, and lastly, whether breast feeding presents any troubles or difficulties. The patient's general health and outlook on life are noted during this enquiry. The mucous membranes are examined for signs of anæmia. A note is made of the state of the abdominal musculature and whether involution is so imperfect that the fundus of the uterus can still be felt. Pelvic examination includes the observation that satisfactory healing has occurred in any sutured laceration, and that, on straining, there is no undue prolapse of the vaginal walls and uterus. Vaginal examination should be performed and the size and position of the uterus noted. The uterus may be retroverted. There is seldom any advantage in attempting to treat this, unless the displacement of the uterus is related to uterine prolapse. The vagina and cervix should be inspected. Erosions of the cervix should be cauterized if they are giving rise to discharge, but it is well to wait for another 6 weeks before doing this, as many erosions will be found to heal spontaneously by that time.

The site of any backache should be ascertained. If this pain is referred to the sacral area it may be associated with prolapse or retroversion, but if to the lumbar region, it is more likely to be associated with a faulty posture and exaggerated lordosis. The pain may also occur over one or both sacro-iliac joints. Appropriate additional investigations and treatment should be started at once for any disability discovered at these postnatal examinations.

The postnatal visit provides an ideal opportunity for screening patients for pre-invasive carcinoma of the cervix by cervical cytology, and when facilities become available vaginal smears should be taken from all patients at this time.

It also gives an opportunity for advice on family planning. (See *Diseases of Women* by Ten Teachers.)

TOXÆMIA OF PREGNANCY

CLINICAL FEATURES AND MANAGEMENT

TOXÆMIA of pregnancy is an inadequate term used to cover a condition peculiar to pregnancy whose ætiology is unknown, but which was formerly attributed to the actions of a hypothetical toxin. Although this theory is no longer believed, the term 'toxæmia of pregnancy' has been retained because a better one has not been found. It no longer implies any idea of a toxin in ætiology. The term now in general use is *pre-eclamptic toxæmia*, often abbreviated to P.E.T. Pre-eclamptic toxæmia is so called because if it is allowed to progress it may give rise to *eclampsia*, in which condition the woman is subject to fits, and her life and that of her fœtus are in great danger. The word eclampsia does not in fact mean fits, for the original Greek word means 'to flash out'. This is because of the observation that many women who ultimately have fits and go on to coma may experience the visual symptom of flashes of light before having fits. This catastrophic complication of pregnancy was known to Hippocrates in about 500 B.C. but little further was known about it until 1843 when John Charles Weaver Lever of Guy's Hospital found that many of the women who had fits also had albumin in the urine. It was not until this century, with the widespread use of the sphygmomanometer, first introduced into Britain by Sir Clifford Allbutt, Regius Professor of Medicine at Cambridge, that it came to be recognized that eclampsia and pre-eclamptic toxæmia were also associated with hypertension.

The syndrome of pre-eclamptic toxæmia consists of the three physical signs, hypertension, proteinuria and œdema. It is important to realize that these are signs and not symptoms. Indeed much of the danger of pre-eclamptic toxæmia is due to the fact that in the early stages there are no symptoms at all, and yet if the disease progresses both baby and mother may lose their lives. Knowing this, it is obvious that early recognition of the syndrome depends on the pregnant woman making frequent visits to her doctor, and at each visit he must conscientiously record the blood pressure and the presence or absence of proteinuria and œdema. There is never any excuse for omitting to record these findings. Since the growth of antenatal care in this country in the past 40 to 50 years there has been a great reduction in the incidence of eclampsia and in maternal and fœtal death due to it. This is almost certainly due to the early recognition and treatment of pre-eclamptic toxæmia, so that the course of the disease is

arrested or its progress slowed down before eclampsia supervenes. However the incidence of pre-eclamptic toxæmia itself has not changed at all, so that the dangers of eclampsia would still be present if careful antenatal care were not practised.

The ætiology of pre-eclamptic toxæmia is unknown although theories abound. It is therefore proposed to deal with the subject here primarily at the clinical level, and to leave ætiology and pathology until later. (See p. 192.) This empirical approach has already brought a large measure of success in dealing with the disease in everyday practical obstetrics. Although research will bring understanding of the disease process, much has been done and will continue to be done in the practical sphere without this comprehension.

THE NATURAL HISTORY OF PRE-ECLAMPTIC TOXÆMIA

The signs of pre-eclamptic toxæmia usually develop in the order of œdema first, followed by hypertension, followed by proteinuria. This sequence is not invariable although it is the most common. Any order of development is in fact possible, and any one of these signs should put the doctor on his guard. It has become the convention to diagnose pre-eclamptic toxæmia only if two out of the three signs are present. This may be useful for statistical purposes but may be very misleading in practice, for any one of these signs may be of serious significance even when present in isolation.

Œdema in pregnancy

In every pregnancy there is a retention of nutrients to provide for the growth of the fœtus, placenta, uterus and breasts and also to provide the fluid of the liquor amnii, the increased blood volume and extracellular fluid, and the deposition of fat stores. In the causation of œdema the factors of importance are water and sodium. It has been estimated that the increase in extra-cellular water in a woman of average weight of 55 to 60 kg. (120 to 132 pounds) before pregnancy will be of the order of 6 litres. However this figure is very variable even in completely normal pregnancy. The storage of sodium in pregnancy has been estimated at about 850 mEq. Because œdema occurs so commonly in pre-eclamptic toxæmia it is often thought that a main feature of the condition is a disorder of water and sodium metabolism, one or other or both being retained in excess of the normal amount. This hypothesis is not yet proven though there is much suggestive evidence in its favour.

It was hoped that excessive weight gain during pregnancy would give an early warning that fluid retention in excess of normal was occurring. This would help to pick out those patients who were liable to develop

pre-eclamptic toxæmia within a short time. If this were so, undue weight gain would be a most useful sign of the syndrome. However, in practice it is found that only about 50 per cent of those women who gain excessively during the middle part of pregnancy do in fact develop any other signs of pre-eclamptic toxæmia. Although weight gain is a relatively unreliable sign of early pre-eclamptic toxæmia it is sufficiently valuable to make it worthwhile to record the patient's weight at every visit to the antenatal clinic.

During an average normal pregnancy a woman will gain about 11 kg. (24 pounds). This gives an average weight gain of about 4 pounds per month or 1 pound per week. It must be recognized that these are very rough figures and there will be great individual variation, but only very few women will gain more than 6 pounds in a month, so that a gain of more than 1½ pounds per week is unusual, and it may have pathological significance.

A sudden increase in weight of about 1 kg. (2 to 3 pounds) in the course of a week almost certainly means that the woman is retaining an excessive amount of fluid, for of the other seven components of weight gain none are so liable to fluctuate as rapidly as this. However it is well to make sure that the patient is not wearing heavier clothes than she did on the previous occasion of weighing. Ideally each woman should be weighed wearing only a light dressing gown provided in the clinic, but this is often impracticable in large clinics because of the time involved. If there are no signs of preeclamptic toxæmia other than a sudden increase in weight the patient may be sent home, but she should be seen again within 2 or 3 days.

More significant than weight gain is the presence of clinically demonstrable œdema, though even this sign needs care in interpretation. The place where œdema usually first shows itself is near the ankles. At every visit of the patient it should be looked for by pressing firmly but gently over the tibia just above the medial malleolus. Slight pitting œdema at this site is not uncommon in normal pregnancy because the venous pressure in the legs is always raised, partly by the heavy uterus pressing on the common iliac veins and partly because of the increased venous return into the common iliac veins from the pelvic area. Added to this is the fact that the tissue fluid throughout the body is increased and much of it is retained in the legs; therefore only a slight increase in the total fluid content of the legs will produce clinically manifest œdema. Such non-significant œdema is especially common in warm weather, or when a woman pursues an occupation involving standing or sitting for long periods, and when there are varicose veins. Possibly with varicose veins the venous pressure is even higher in the legs than is normal in pregnancy.

Occasionally there is massive œdema of the legs up to the knees without any other sign of pre-eclamptic toxæmia. Although on this one sign alone it is not possible to make the diagnosis of toxæmia it is wise to admit the

patient to hospital in case it presages worse to come. With rest the œdema usually diminishes and hypertension does not follow. The cause of this condition is not known and until it is it should be treated with respect.

When œdema affects the fingers, or is present round he eyes, it is of more serious significance than when it is confined to the legs. Since gravity has little effect on the accumulation of extra-cellular fluid in these two sites such œdema must mean that some other factor is operative and is acting in many areas of the body, of which these two are the most obvious clinically. What this extra factor may be is not known, but theories will be considered later. When œdema of the fingers occurs the patient should be observed with increasing care, and even if there are no other signs of pre-eclamptic toxæmia she should be seen again within 2 or 3 days. Oedema of the fingers is most often recognized by the fact that the patient feels that her rings are tight, and often she will be found to have removed them. Frequently she will not mention this and so she ought to be asked routinely if her rings are comfortable. It is more difficult to recognize œdema round the eyes, but on enquiry the patient may say that her eyelids feel tight when she wakes up. With the activity of blinking the œdema disappears and the feeling of tightness goes.

It will be seen that neither weight gain alone, nor œdema alone can establish the diagnosis of pre-eclamptic toxæmia. But either or both of these signs make it imperative to seek further evidence of toxæmia either at that visit or in a few days. These signs may be the first hint of trouble to come.

The blood pressure in pregnancy

The blood pressure in pregnancy must be recorded at every visit to the antenatal clinic and there is never any excuse for omitting this observation. Some points in technique require emphasis. The upper arm must be bare so that the cuff of the sphygmomanometer can rest evenly over its whole area. The cuff must be evenly applied without undue tension or slackness, and the part of the cuff containing the balloon must be placed over the brachial artery on the arm. The artery should be palpated below the cuff on the medial side of the biceps tendon before the stethoscope is placed over the artery. If a bell stethoscope is used care should be taken to see that it rests evenly on the skin, for if the upper edge presses on to the artery and indents it the sounds heard are dependent on this pressure and not on that in the inflated cuff, so a spurious reading, usually too high, is made. The cuff should be inflated rapidly to a point above the systolic pressure. This can be determined by palpating the pulse at the wrist as the cuff is inflated.

The systolic pressure is taken as that when the first sounds are heard. The measurement of the diastolic pressure is more difficult. It is that

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pressure at which the sound of the note changes and becomes more muffled. A point often wrongly taken as the diastolic pressure is that at which the sounds disappear, but not uncommonly the sounds do not disappear until the pressure is below 20 mm. or even less. It has been recommended that the blood pressure might be recorded in some fashion such as 120/80–40 mm., meaning that sounds are first heard at 120, they become muffled at 80 and finally disappear at 40 mm. This perhaps ought to become more common practice.

Another difficulty arises in women with fat arms. Although there is no doubt about the general association of obesity and hypertension, some obese women are wrongly thought to be hypertensive because of the inaccuracies of the method of recording their blood pressure. With a fat arm a much greater pressure is required to occlude the artery than in a more normal arm. When such recordings are compared with observations made with an intra-arterial needle they are nearly always found to be too high, sometimes by as much as 8 mm.

In general the blood pressure should be recorded with the patient comfortably at rest either in the sitting position or lying down. If she is not familiar with the procedure it should be explained to her, for the sudden increase in pressure in the cuff on the arm may be disconcerting and so emotionally cause a rise in the recorded pressure. Of course it is well known that anxious patients have an increased heart rate and by increasing the cardiac output the blood pressure may be temporarily raised until the heart rate is restored to more usual levels, which usually happens after a short rest. Since the first visit to the antenatal clinic is often an anxious one for the patient it is common to find that the first recorded blood pressure is higher than those of subsequent visits. Some obstetricians therefore advise that this reading may be ignored in assessing the progress of the patient's blood pressure throughout pregnancy. However it is wise to note that the blood pressure is liable to rise in the particular woman if she is under stress and that her arterial pressure may therefore be labile. This may or may not mean that her blood pressure will rise under the physiological and emotional stresses of pregnancy, but the tendency to hypertension is present. Of course the blood pressure may be temporarily raised if the woman has hurried to get to the clinic and any high reading should be checked after she has had time to rest a little.

If the patient changes suddenly from the supine to the standing or sitting position her blood pressure will fall because of pooling of blood in the legs. The fall may be enough to cause her to feel faint because of the temporary diminution in the cerebral blood flow. Another mechanism is operative in many pregnant women near term when they are lying down. Here the mass of the pregnant uterus may totally occlude the inferior vena cava, as may be shown by X-ray methods, and the venous return to

the heart is greatly diminished. The blood pressure may then drop precipitously, even to the point of fainting. This has been called the *supine hypotensive syndrome.*

When the blood pressure as recorded by the sphygmomanometer is compared with that recorded through an intra-arterial needle the error in the use of the cuff is of the order of ± 8 mm. In ordinary obstetric practice it is obviously not possible to record intra-arterial pressures, nor is it necessary, because the sphygmomanometer gives a series of blood pressure readings recorded by a reasonably standard method and it is the changes in the measurement that matter, rather than a single casual reading.

There is a tendency for the blood pressure in pregnancy to be slightly below that found when the patient is not pregnant, although this is not invariably the case. The fall in both the systolic and diastolic pressures is most marked in the middle trimester and then the pressure begins to rise nearly to non-pregnant levels in the last two months. The pulse pressure, that is the difference between the systolic and diastolic pressures, tends to be greater in pregnancy than in non-pregnant women. The reason for the slight fall in blood pressure during pregnancy, which can be 30 or more mm., is not fully explained. Possible factors are those of decreased viscosity of the blood and diminished vascular resistance due to redistribution of blood, especially to the vessels of the skin and the pelvis, though there are probably others.

There is some disagreement as to what may be regarded as a normal blood pressure in pregnancy. One of 120/80 mm. or less is deemed normal by all. One of 140/90 mm. or more is deemed abnormal by all, and in most clinics 140/90 mm. is taken to be the dividing line between physiology and pathology. Some will have other standards such as 130/80 or 130/85 mm. above which level they will diagnose hypertension, but a majority feel that this is over-cautious and leads to the inclusion of a larger number of patients than is necessary in the category of pre-eclamptic toxæmia and hypertension, especially when it is realized how relatively inaccurate is the clinical measurement of blood pressure.

The standards of hypertension acceptable in general medicine are of no value in obstetrics. A pregnant woman with a blood pressure of 140/90 mm. is beginning to run into danger; at 150/100 mm. she stands a chance of her fœtus dying; and at 160/110 mm. she is seriously ill and may develop eclampsia; at 200/140 mm. her life is in great danger. The reasons for the difference of standards between general medicine and obstetrics are the rapid rate of rise of blood pressure which may occur in obstetric practice, the presence of the fœtus which is also at risk, and the fact that the pathophysiology of pre-eclamptic toxæmia is different from that of the ordinary form of hypertension, whether it is benign or malignant.

Proteinuria in pregnancy

The term 'proteinuria' is more correct than 'albuminuria' which is often used, for the protein found in the urine, although largely consisting of the relatively small molecules of albumin, also consists of other bigger molecules such as globulins as well. In some conditions other proteins may be present.

Protein in the urine is most easily detected by means of test paper strips, marketed under the name of 'Albustix'. The strips are impregnated with the indicator tetrabromphenol blue which changes colour from the yellowish normal to green or blue, when dipped in a specimen containing protein. The depth of the colour change may be compared with a standard which is printed on the label of the bottle of paper strips and which gives an indication of the amount of protein in the urine in mg. per 100 ml. This is the test most generally used today. Older tests which are perfectly satisfactory, though more time-consuming, are those of adding salicyl-sulphonic acid or of boiling the urine. For the salicyl-sulphonic acid test the urine is first filtered if it is not quite clear and then a few drops of the saturated or 25 per cent solution of the reagent are added. If protein is present a cloudy precipitate forms. In the boiling test the upper inch or so of a test tube nearly full of urine is heated. A cloudy precipitate forms with phosphates or protein. When a few drops of 5 per cent acetic acid are added any precipitate due to phosphates disappears whilst that due to protein remains.
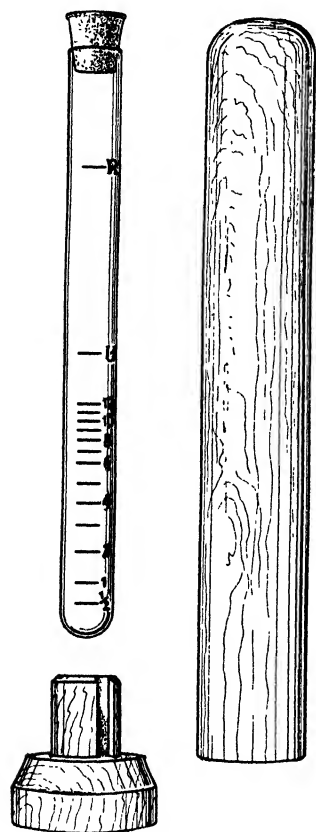
FIG. 75.

If the patient is in hospital and the urine is being examined daily the Esbach's albuminometer is sometimes used. The diagram (Fig. 75) shows the graduated tube which fits into a stand and is then covered with a wooden sheath. The output of urine over 24 hours is collected and when tested should be clear, or should be made so by filtering. It should also be acid, and if it is not acetic acid should be added until it is. The specific

gravity of the urine should be reduced if necessary to 1008 by the addition of water. When the urine has been prepared it is put into the Esbach tube to the level marked U. The Esbach reagent (picric acid 10 g., citric acid 20 g. and distilled water to 1 litre) is added up to the mark R. The stopper is put into the tube and the fluids are gently mixed. The tube is then placed in its stand and covered with its sheath. After 24 hours exactly the sheath is removed and the amount of precipitate read off from the graduated marks. These give the amount of protein in the urine in parts per thousand, i.e. grams per litre. This is not an accurate method but provided the test is done under standard conditions daily the series of readings will show roughly whether the proteinuria is increasing, decreasing or staying the same. If more accurate determinations are needed, together with an assessment of the exact nature of the proteins in the urine, these must be made by investigations in the laboratory. In general this is not necessary for the clinical management.

The presence of proteinuria in pregnancy is always a potentially serious matter and demands immediate investigation. The main causes are:

> Contamination from vaginal discharge.
> Pre-eclamptic toxæmia.
> Urinary tract infection.
> Chronic nephritis.

Contamination of the urine specimen must first be excluded by obtaining a clean catch specimen of urine. This is done by thoroughly cleansing the introitus of the vagina, especially in the area of the external urinary meatus, then, while keeping the labia minora apart, a few ml. of urine are passed to wash out the urethra. The next outflow of urine is collected into a wide-mouthed vessel which must be sterile if the specimen is needed for bacteriological investigation. The cleansing of the vulva may be done by the woman herself but the whole process should be supervised by a nurse who fully understands it. A hint that proteinuria is due to vaginal contamination may be gleaned from examining the urine under the microscope when many vaginal squames may be seen, but this does not exclude proteinuria due to other causes.

Urinary infection as a cause of proteinuria can be excluded by examining the urine under the microscope. When infection is present pus cells and bacteria can be seen. The observation must be confirmed by bacteriological examination in the laboratory.

Proteinuria due to chronic nephritis is very uncommon in pregnancy. The disease is usually recognized from the history, but if it is not, the proteinuria is commonly present throughout the whole of pregnancy. This is quite different from the history of both toxæmia and urinary infection, which most often occur for the first time in the last and middle trimesters respectively. If chronic nephritis is suspected the urine should

be examined for renal casts and investigations of the urine by chromato-graphy should be made, together with blood urea estimations and various renal function tests. These tests seldom prove very helpful during pregnancy, for in severe chronic nephritis the patient seldom becomes pregnant, and in the milder cases encountered during pregnancy no change may be found except persistent proteinuria, and this demands prolonged follow-up after the pregnancy is over before a diagnosis can be made.

After exclusion of these other causes of proteinuria it can then be properly attributed to pre-eclamptic toxæmia, and this finding is always of serious significance. Proteinuria of toxæmia is associated with a high incidence of fœtal death for reasons which are not known. Because of this, and because of the risks of eclampsia developing, a patient with such proteinuria must be admitted to hospital without delay. If the blood pressure should also be raised, even if only slightly, she should not be allowed to go home from the clinic, but should be taken in forthwith. She might very soon have an eclamptic fit.

There are other causes of proteinuria in pregnancy besides those just mentioned, but they are very much rarer. One of the more interesting is *orthostatic proteinuria.* Orthostatic means 'standing straight', and the proteinuria only occurs after the patient has been on her feet for some time. At night in the recumbent position the proteinuria disappears. It is not peculiar to pregnancy and is not uncommon in adolescents, but it can fairly easily be provoked in a number of pregnant women by having them stand in extreme lordosis for some time. It is thought that in this posture the left renal vein is compressed where it crosses the vertebral column over the front of the aorta and beneath the superior mesenteric artery. This presumably raises the venous pressure in the left kidney, and it has been shown that in this condition most of the protein in the urine comes from the left kidney. This diagnosis is most improbable in the fully ambulant pregnant patient. Unexplained proteinuria necessitates admission to hospital. But in some women admitted to hospital the proteinuria promptly disappears and in some of these cases the condition of orthostatic proteinuria can be shown to be present by testing the urine for protein before and after activity.

During normal labour it is not uncommon for protein to appear in the urine. This seems to be associated in some way with the exertion, though it may be postural as suggested in connexion with orthostatic proteinuria. It may be comparable with the proteinuria that may often be found in young healthy adults shortly after violent exercise.

Sometimes even more uncommon causes of proteinuria in pregnancy such as acute nephritis or disseminated lupus erythematosus may need consideration. (See pp. 206 and 209.)

Clinical features of pre-eclamptic toxæmia

In principle the recognition of pre-eclamptic toxæmia, as shown by the presence of one or more of the three physical signs hypertension, œdema and proteinuria, is easy. But in practice the significance of these three in an individual patient demands careful elucidation. The difficulty lies in the fact that the transition from normal pregnancy to that of abnormality is not distinct, and to steer a course between over-caution and sensible precaution needs nice judgment.

Despite much research and careful antenatal care it has not so far been possible to reduce the incidence of pre-eclamptic toxæmia, which occurs in between 3 and 10 per cent of all pregnancies, depending on the population from which the statistics are drawn. The aim in management must therefore be to recognize toxæmia early and so to prevent serious illness and possibly death of the mother and stillbirth or neonatal death. It is valuable to be able to pick out at an early stage in antenatal care any groups of patients who may be at especial risk of developing the syndrome. This does not imply that others may not develop it, so that great care and watchfulness is needed in all patients, but in some types of patient a relatively increased risk of the development of toxæmia makes the doctor even more alert for its appearance.

The incidence of toxæmia will be of the order of 10 per cent in all primigravidæ, and only about half this in multigravidæ. Those who have had toxæmia in a previous pregnancy have a greater likelihood of having it in subsequent ones. A woman who had toxæmia with her first pregnancy has about a 50 per cent chance of developing toxæmia in a second pregnancy. If she has had toxæmia in two pregnancies the risk increases to about 75 per cent with the third, and if she has had toxæmia with three pregnancies her chances of developing it a fourth time are of the order of 90 per cent. These figures are of course only a general guide to the risk. All primigravidæ should have their babies in hospital (for a variety of other reasons as well) and any woman who has had toxæmia before should also be booked for hospital confinement.

It is well known that the blood pressure tends to rise with age and all older women, especially those over the age of 35 years, have an increased risk of pre-eclamptic toxæmia. Primigravidæ over the age of thirty demand especial care. It is known that the incidence of pre-eclamptic toxæmia is raised in essential hypertension and in chronic nephritis, and probably with chronic pyelonephritis. In diabetes mellitus the incidence of toxæmia is of the order of 20 per cent. With multiple pregnancy the incidence is also of the same order. Obesity too is a factor associated with an increased chance of developing toxæmia. Hydatidiform mole is a rare complication of pregnancy but it is associated with a high incidence of pre-eclamptic

toxæmia, and this disease is unusual in that the toxæmia comes on in the earlier months of pregnancy, a fact which is of particular interest in relation to the cause of toxæmia, as it shows that it can occur in the absence of a fœtus. A high incidence of toxæmia is found in hydrops fœtalis, another condition in which the placenta is enlarged. To obtain the best results in terms of maternal health and fœtal survival all the groups of patients mentioned above should be under specialist care in hospital.

The signs of pre-eclamptic toxæmia do not usually occur until the last 8 weeks of pregnancy and most cases are not seen until the last 3 or 4 weeks. It is best if the patient is seen every week from the 32nd week, but this is often modified so that she is seen at the 34th and 36th weeks and thereafter weekly.

MANAGEMENT OF PRE-ECLAMPTIC TOXÆMIA

In the first 6 months of pregnancy if a woman has a blood pressure of 140/90 mm. or more the diagnosis is likely to be one of essential hypertension. If she has proteinuria chronic nephritis or pyelonephritis must be considered. These disorders will be dealt with subsequently. Only if hypertension, œdema or proteinuria develop later in pregnancy is pre-eclamptic toxæmia the most likely diagnosis.

Proteinuria which is not obviously due to urinary infection or to contamination of the specimen by vaginal discharge demands admission to hospital because this may be an indication of toxæmia of some severity.

Hypertension of the order of 140/90 mm. or more in the last 8 weeks of pregnancy usually requires admission of the patient to hospital. A rise in pressure to this level from previously lower levels is of more importance than a pressure which has been about 140/90 mm. throughout the pregnancy. Hypertension of this degree earlier in pregnancy may be managed by resting the patient at home and perhaps by giving a barbiturate such as phenobarbitone 30 mg. (gr. $\frac{1}{2}$) two or three times daily. She should be seen in 2 or 3 days to make sure that the blood pressure is not rising. At any time in pregnancy a diastolic pressure of the order of 95 to 100 mm. necessitates *immediate* admission to hospital and it is best if the patient does not go home from the clinic, even to return the same day. In the last few weeks of pregnancy a diastolic pressure of 100 mm. or more is serious, and even more so if the patient feels ill or has any symptoms.

Oedema of the legs of minimal degree without signs of rise of blood pressure or proteinuria does not require admission to hospital. Rest at home with the legs up and preferably in bed is the best diuretic and this may be aided by giving a diuretic such as chlorothiazide 500 mg. twice

daily. Patients are often advised to restrict their intake of salt, but there is no evidence of the value of this. The woman should be seen in 2 or 3 days to check the blood pressure and the urine. In general on this régime the œdema subsides and the weight diminishes, but it is often necessary to continue the exhibition of the diuretic till term. If it is stopped before this it is not uncommon for the œdema to recur. It should be remembered that the chlorthiazide diuretics also cause a potassium diuresis and this should be offset by giving potassium salts and by giving the diuretic for only 5 days out of every 7. When œdema is more widespread in the fingers and face more care is needed and the patient should be seen every few days so that if the condition does not rapidly improve she may be admitted to hospital. If the œdema should be massive, so that pitting may be observed right up to the knee and even on to the abdominal wall, or if there is great œdema of the fingers and face, the patient should be admitted to hospital without delay. There is a high likelihood that hypertension and proteinuria will develop quite quickly.

It will be seen that any sign of toxæmia other than the most mild œdema requires admission to hospital for further investigation and treatment.

Management of pre-eclamptic toxæmia in hospital

The aim of treatment is to prevent fœtal death and eclampsia. There are therefore two facets to treatment, medical and obstetric. Obstetric treatment is devoted to delivery of the baby at the most auspicious time. This must obviously be before it dies *in utero*, and yet one must be sure that it is mature enough to survive once it is delivered. There is very little chance of the mother becoming eclamptic once the fœtus is delivered, and a mature baby has a better chance of survival once it is in its cot than in the relatively noxious environment of the uterus in a woman who has pre-eclamptic toxæmia. In brief the best treatment of pre-eclamptic toxaemia is delivery, and this holds for both the mother and the baby. However this desirable treatment is not always immediately possible; in particular because the fœtus may not be mature enough to be able to survive apart from the mother. Therefore one has to wait for it to grow adequately until it is safe for it to be delivered. It is in this waiting period that medical treatment has its part to play. It is directed to keeping the blood pressure especially at safe levels, that is below 100 mm. diastolic. This is done by rest in bed, the use of sedatives and sometimes hypotensive agents. Oedema usually subsides with the rest in bed, but may be helped by giving diuretics, and these also seem to be valuable in lowering the blood pressure. There is nothing specific to be done about proteinuria, though with rest in bed it sometimes disappears.

Mild pre-eclamptic toxæmia

For proper observation certain routine charts must be kept. The blood pressure must be recorded at least twice daily and more often if the condition worsens. Oedema must be looked for twice daily. Often the fluid shifts from the legs to the sacral region when the patient is recumbent much of the day, and should be looked for here. The urine should be tested twice daily for protein and every morning an Esbach's test (p. 172) should be set up to be read 24 hours later and charted. Occult œdema may be detected by weighing the patient under standard conditions twice weekly, and properly kept intake-output charts will show any abnormal retention of fluid. In many hospitals intake is difficult to record with any accuracy because of shortage of staff, but output is easier and should always be recorded. Oliguria may precede major rises in blood pressure and also eclampsia.

The uterus should be palpated daily and the fœtal heart rate counted at least twice daily. It is very common for the fœtus to fail to grow in the presence of toxæmia in the mother, and as fœtal size is one of the ways of estimating fœtal maturity it may be misleading in this respect. The fœtal heart rate is recorded so that fœtal death or distress may be recognized early. It is of interest, though as yet unexplained, that if the fœtus dies *in utero* it is usual for the severity of the toxæmia to diminish.

It is obvious that the toxæmia may improve, stay the same or get worse. If the condition worsens, considerations to be dealt with under moderate toxæmia will enter the picture. If the condition improves, as shown by the return to normal of the blood pressure and its maintenance at that level for a few days together with the disappearance of the œdema, increasing activity may be allowed to the patient. At first she may be allowed out of bed for more and more of the day and if this does not cause deterioration she may be allowed to go home. However, once she has shown signs of toxæmia it is quite likely that they will return and therefore she should be enjoined to rest, be given a sedative such as phenobarbitone to help her in this and be seen very frequently until the baby is delivered. It is wise to have her come to the clinic twice weekly and to admit her again if any sign of toxæmia recurs.

If the severity of the toxæmia stays much the same and is still deemed to be mild, the patient must be kept in hospital under simple medical treatment consisting usually of sedatives and sometimes diuretics, but with the emphasis mainly on rest, much of it in bed. In a fair proportion of cases labour will start spontaneously and the mother will be delivered without trouble, to the relief of all. When labour has not started before the end of the 40th week induction of labour should be performed. This is because the combination of postmaturity with pre-eclamptic toxæmia is

particularly lethal to the baby. Indeed the recent Perinatal Mortality Survey showed that a blood pressure of 140/90 mm. recorded at any time in pregnancy, even though it later returned to more normal levels, with a pregnancy of more than 40 weeks duration was associated with a higher incidence of perinatal death than would be expected with postmaturity alone. Thus there are good grounds for not allowing a patient with hypertension at any time in pregnancy to go beyond her expected date, and this is especially so if the hypertension is still present at term.

The induction of labour for mild pre-eclamptic toxæmia should be by rupture of the membranes. There is no place for medical induction by such methods as the administration of castor oil, a hot bath and an enema which are so uncertain in their results. The intention in toxæmia is to have the patient delivered, so the most efficacious method available must be used. (See Induction of Labour, p. 571.) If the surgical induction of labour does not bring the patient into labour within 24 hours an intravenous oxytocin drip may be of help. There is no reason why the drip should not be given earlier and even at the time of the rupture of the membranes if desired. Some believe that the oxytocin drip may cause a rise in blood pressure, but in these mild cases of pre-eclamptic toxæmia this seems not to be the case. However these patients must be watched with extreme care and if there is any increase in the blood pressure the drip should be stopped immediately.

Sometimes the surgical induction of labour fails even when it is aided by the oxytocin drip. Under these circumstances the right course at the present day is to proceed to Cæsarean section. There is no doubt that the risks to the fœtus are increased by the toxæmia and this is why the rupture of the membranes is done. After rupture of the membranes if labour does not follow the risks to the fœtus are increased still more because of the possibility of intra-uterine infection and perhaps by the altered blood supply to the uterus caused by the lessening of the uterine volume by the escape of liquor. The only way to be sure of liberating the fœtus from the increased risks to its life is by Cæsarean section, and after proper explanations to the mother, and if need be to the father, this should be done. It is usual to undertake this course if the mother is not in labour within 48 hours or so of the rupture of the membranes, because this is the time at which it can be shown that intra-uterine invasion by bacteria is beginning in earnest, and that the fœtal mortality begins to rise.

Moderate pre-eclamptic toxæmia

Proteinuria is always of serious prognostic significance for the fœtus, and therefore induction of labour should be performed if proteinuria persists for more than about 10 to 14 days and the fœtus is deemed mature

enough. If the fœtus is not mature enough there is nothing to be done but wait until it is, knowing that the risks are great.

When the blood pressure is of the order of 150/100 mm. everything possible should be done to control the toxæmia, or if the fœtus is mature enough the patient should be delivered. If the patient is near term, and has a blood pressure of this height for some hours, artificial rupture of the membranes is indicated and, as discussed under mild toxæmia, if the patient is not delivered within 48 hours of the induction Cæsarean section should be performed. If the toxæmia worsens after the rupture of the membranes the Cæsarean section should be done before this time has elapsed. It is however more usual for the toxæmia to improve slightly after the membranes have been ruptured, and the reason for this is not known.

If the blood pressure is hovering about the 145/95 to 150/100 mm. mark over some hours or perhaps a few days and it is thought best not to induce labour because the fœtus is not yet big enough an attempt should be made to lower the blood pressure. The main therapeutic agent is bed rest, which should be complete. Barbiturates should be given because of their sedative effect and their indirect effect of lowering the blood pressure. Which barbiturate is chosen is quite immaterial. The object is to make the patient slightly drowsy throughout the day and diminish her anxiety. The drugs most often used are phenobarbitone in doses of 30 to 60 mg. ($\frac{1}{2}$ to 1 gr.) by mouth or amylobarbitone in doses of 90 to 180 mg. (3 to 6 gr.) and occasionally even larger doses. The frequency of these doses will depend on the clinical state of the patient and her response to them. In general they are given two or three times a day, but they may have to be given 4- or 6-hourly sometimes. This régime is often enough in itself to lower the blood pressure to safer levels. If it is not then various hypotensive drugs may be used.

There are many hypotensive drugs on the market and for the purpose of treating the hypertension of pre-eclamptic toxæmia no one appears to be better than any other. It is better to become familiar with one hypotensive rather than try a host of them in different cases. If a mild hypotensive agent is needed *reserpine* seems to be valuable in many cases. It is given by mouth in doses of about 0·25 mg. three times daily. It usually has a calming effect as well as its hypotensive effect and some prefer to use it in place of the barbiturates. However, it can cause severe depression and a few patients may even become suicidal, so that with any hint of side-effects the drug should be stopped. When a greater hypotensive effect is needed *methyldopa* is helpful. It is given in doses from 0·5 G. to 4 G. daily. At first it is best to start with a dose of about 0·25 G. two or three times daily and then gradually to modify the dosage and timing in accordance with the effect on the blood pressure. It is possible to use other drugs such as pentolinium, mecamylamine, bretylium and guanethidine but these all

seem to be more difficult to use in obstetric practice and to vary more greatly in their effects. Moreover they tend to cause postural hypotension, sometimes of severe degree when the patient is on her feet. Nevertheless those who are familiar with them can use them quite safely.

If the blood pressure falls whilst the patient is under medical care, and unfortunately this is relatively rare, then it may be continued until the fœtus is mature enough for delivery, either following surgical induction of labour or by Cæsarean section. If the treatment fails then induction or Cæsarean section must be done before matters get worse. Since rupture of the membranes may cause some improvement it is sometimes reasonable to do this and see what effect it may have both on the toxæmia and in getting the patient into labour. If she does not go into labour then Cæsarean section is advised.

Severe pre-eclamptic toxæmia

When the diastolic pressure is in the region of 110 mm. the fœtus is liable to die and the mother may soon develop eclampsia. Quite frequently the rise of blood pressure to this sort of level is rapid, occurring over the course of a very few hours. There is then little time to be wasted. In general the best treatment for these patients is to deliver them as soon as possible, often by Cæsarean section. If the baby is premature it may be reasonable to see if medical treatment will have any effect in the hope that if the blood pressure is lowered the pregnancy may continue and the baby can be delivered at a better time. This hope is not often realized. For this purpose medical treatment consists in giving large doses of hypnotics of one sort or another. Preference is usually given to *amylobarbitone* 360 mg. (6 gr.) and this is repeated in 180 mg. (3 gr.) doses as the need arises. Most often this will be 4- or 6-hourly but it can be given more or less frequently. On this régime the patient should be asleep nearly the whole time and the doses and their timing should be adjusted to maintain this state. *Paraldehyde* may also be used as an adjunct to the amylobarbitone and is best given in 5 to 10 ml. doses intramuscularly. It can also be given per rectum. Many people object to the smell of paraldehyde but this can scarcely be advanced as a contra-indication to its use for it is very safe, even though rarely it causes excitement. The only persons inconvenienced by its administration are the attendants; the sleeping patient is not troubled. Sometimes hypotensive agents have been used and the veratrone alkaloids have had a vogue. However, it is a relatively dangerous drug to use in that it may cause serious circulatory collapse, and nausea and vomiting are almost invariable. Less serious in its side-effects is *pentolinium* ('Ansolysen') which may be given in 5 mg. doses subcutaneously three times a day, though at first it is wise to try the effect of only 2·5 mg.

Only very few patients will be permanently improved by these drastic medical measures which should be abandoned if they are not having any good effect after a few hours. In those in whom a good effect is obtained the therapy should be continued for about 48 hours and should then be slowly lessened, observing the effect all the time. If the therapy fails then Cæsarean section is usually best in the interests of both the mother and the baby. Even if the fœtus is very premature, say at 32 weeks, Cæsarean section is still usually best, for if the baby is left where it is in the uterus it will surely die. At least if it is delivered alive it stands a chance of survival in a good premature nursery. Also the dangers to the mother are greatly diminished by delivery so that Cæsarean section is the best way out of a nasty dilemma for all concerned.

Imminent eclampsia and fulminating pre-eclampsia

Imminent eclampsia and fulminating pre-eclampsia are terms applied to cases of severe pre-eclampsia in which the disease progresses very rapidly. All lesser grades of pre-eclampsia may quickly change into imminent eclampsia at any stage in the disease. The diastolic blood pressure rises to a height of over 110 mm. and even up to 140 mm. or more. Massive œdema affecting the face, hands and legs becomes manifest in the space of an hour or two and the output of urine falls to negligible levels. If the urine is boiled or salicylsulphonic acid is added it becomes virtually solid with the protein precipitated. The patient feels ill and may have some of the symptoms of eclampsia such as headache and flashes of light before the eyes, together with some epigastric pain. This condition is an acute obstetric emergency. Medical treatment is only employed until the patient can be transported to the operating theatre for Cæsarean section to be done. Only so will eclampsia be prevented and the fœtus saved. In hospital an injection of morphia or 'Omnopon' 20 or 30 mg. ($\frac{1}{3}$ to $\frac{1}{2}$ gr.) may be given or 10 ml. of paraldehyde. If the patient has to be transported by ambulance rectal tribromethanol (Avertin) is the best drug to administer, though if it is not available morphia or 'Omnopon' will have to do. The doctor must under all such circumstances travel in the ambulance with the patient.

Tribromethanol (Avertin) must always be freshly prepared. The instructions are given in each box of the drug. The dose is 0·088 ml. per kg. which in practice is 5 ml. for a patient of average weight and 6 ml. for a heavy one. The appropriate quantity is made up in 40 times its volume of water, i.e. 200 to 240 ml. at 40°C. This temperature should not be exceeded and should be controlled by a thermometer which can also be used as the stirrer. If the temperature of 40°C is exceeded the compound breaks up and produces hydrobromic acid which is irritant and toxic.

When the solution is made up it is tested with the indicator Congo red which is also packed in the box with the drug. If the colour changes at all with the indicator the tribromethanol solution should be discarded. If during preparation hydrobromic acid has not been produced there is no colour change and the solution may be slowly injected per rectum. The Avertin so administered usually puts the patient to sleep and lowers the blood pressure, often to normal levels, and when this occurs the patient may be safely transported. If necessary the dose may be repeated after a few hours but it is to be hoped that Cæsarean section will have been performed before this. The second administration of the drug is not usually so efficacious as the first and no time should be wasted in getting the patient to hospital as soon as possible after the first dose has been given.

Other drugs, especially thiopentone (Pentothal) have been used in imminent eclampsia and fulminating pre-eclampsia but none have been so successful as tribromethanol.

Summary of the management of pre-eclamptic toxæmia

In general the only treatment of pre-eclamptic toxæmia is delivery. Medical treatment only defers delivery in the fœtal interest. The basic medical treatment is rest aided by sedatives and a variety of hypotensives. The two obstetric treatments are surgical induction of labour and Cæsarean section. The way in which these procedures are used depends on the rate of progress of the disease. If the disease is mild and not progressing medical treatment continues. If the course is moderate medical treatment is intensified, though more often induction of labour with an increasing use of Cæsarean section will be needed. In the severe and very severe degrees of pre-eclamptic toxæmia, Cæsarean section is the treatment of choice, medical treatment taking a more subordinate place.

A host of other treatments for various grades of severity of pre-eclamptic toxæmia have been advocated at various times in the past. High protein diets, low protein diets, fluid restriction, salt restriction, purgation, calcium gluconate injections, rectal or intramuscular magnesium sulphate, hypertonic glucose infusions and many others have all had supporters. None of these measures appears to have any influence on the course of the disease except perhaps salt restriction, and most of them are uncomfortable for the patient. Because none of them is of proven value they have been excluded from this account.

The management of a patient with pre-eclamptic toxæmia who is in labour

It will be pointed out later that a precipitating cause of the fits of eclampsia is any stimulus arising outside or from within the patient. The pain of labour is a potent stimulus. Therefore any patient who has

had toxæmia, and especially if it has been of the severe variety, is at increased risk of eclampsia during labour and great watchfulness is needed to prevent this occurring. Nor should it be forgotten that a patient may develop toxæmia for the first time in labour, and go on to eclampsia, there having been no hint of toxæmia during the antenatal period. Even in normal labour the blood pressure rises by up to 10 mm. diastolic. In a patient whose diastolic pressure before labour was in the region of 90 to 100 mm. such a rise can be disastrous. Unfortunately the diagnosis of pre-eclamptic toxæmia is obscured in labour because of the frequent occurrence of proteinuria when the labour is quite normal. However if the amount of protein is more than a very little, pre-eclamptic toxæmia should be suspected. Very rarely massive œdema may become manifest during labour, especially in the face. This is a serious sign and if it occurs it is almost invariably due to a rapidly worsening toxæmia. Therefore, even in a normal labour, the blood pressure must be recorded frequently and the urine tested for protein every time it is voided. When a patient has a rise of blood pressure during labour, and especially if she has had any toxæmia, the frequency of recording of the blood pressure must increase and it may be necessary to record observations every half hour or even every quarter of an hour, for if the condition is deteriorating rapidly and the cervix is not greatly dilated Cæsarean section may be needed.

In a patient known to have pre-eclamptic toxæmia it is essential to try to prevent the disease becoming worse and especially to prevent the onset of fits. Therefore more sedatives and more analgesics are needed for them than for normal patients. The actual doses given will obviously depend on the response of the patient and the severity of the toxæmia, but will in general follow the lines of treatment used in any labour.

The second stage of labour is a time of great exertion during bearing down. The cerebral venous pressure is raised and in a patient with hypertension this may be very serious. Therefore in all patients with toxæmia everything should be ready to perform a forceps delivery without any great delay. If the diastolic pressure is of the order of 95 mm. a forceps delivery should be performed unless spontaneous delivery is rapid. Even with a hypertension below this level it is wise not to allow the second stage to last longer than about half an hour before extracting the baby with the forceps. Usually for forceps delivery in cases of pre-eclamptic toxæmia general anæsthesia should be given. In imminent eclampsia the whole basis of treatment is to prevent the nervous system being stimulated. This cannot be better done than by general anæsthesia. Local anæsthesia is permissible if the toxæmia is not severe and if the patient is very drowsy as a result of previous drug therapy.

There is some evidence that ergometrine causes constriction of blood vessels and may cause a rise in blood pressure. Therefore it would seem

reasonable not to give this drug routinely to women suffering from pre-eclampsia, but conduct the third stage of labour without it. Of course it must still be given if there is postpartum hæmorrhage, for here the hypotensive effects of blood loss will offset any hypertensive effect of the ergometrine.

After labour it is quite common for the blood pressure to rise. In all labours it is imperative to record the blood pressure frequently for the few hours following delivery so that full sedation may be given to prevent any large rise. In patients known to have pre-eclamptic toxæmia this is a time of great risk and treatment with drugs such as 'Omnopon' 20 mg. ($\frac{1}{3}$ gr.) is sensible in all but those whose toxæmia has been mild. If the previous toxæmia has been severe, and especially if eclampsia has seemed imminent during labour, sedation on the lines suggested previously with amylobarbitone and paraldehyde or even tribromethanol, depending on the severity of the condition, should be continued for about 48 hours. It is well known that eclamptic fits are very uncommon more than 48 hours after delivery whatever the height of the blood pressure, so that 48 hours after the birth the heavy sedation should be slowly lifted over the course of 2 or 3 days.

The treatment of pre-eclamptic toxæmia and of imminent eclampsia is much simplified after the delivery, because there is no longer the need to worry about the fœtus. Therapy is therefore entirely medical and consists in keeping the patient virtually asleep over the course of about two days.

During labour the fœtus must be kept under constant observation by regular recording of the fœtal heart rate. It has already been pointed out that the fœtus is at risk of intra-uterine death in pre-eclamptic toxæmia and during labour these risks are added to. Fœtal distress in the first stage of labour may require Cæsarean section or in the second stage of labour may require instrumental delivery. After delivery the baby is likely to need resuscitation from anoxia because of forceps delivery, the toxæmia, general anæsthesia and the large doses of analgesics that may have been needed for the management of the labour. All apparatus should be at hand to deal with this emergency.

ECLAMPSIA

The development of fits is a complication to be dreaded in any childbearing woman. They may of course be due to epilepsy and very rarely due to hysteria, but in the main they are due to toxæmia of pregnancy. Such fits may occur at any time during pregnancy, labour or the first few days of the puerperium, but just as pre-eclamptic toxæmia is most common in the last trimester of pregnancy so is eclampsia, but it is also common during labour and the first few hours following it. This is because of the

painful stimuli of labour and their effect in raising the blood pressure. Recently it has been suggested that the practice of giving routine ergometrine for the prevention of postpartum hæmorrhage has been responsible for some cases of postpartum eclampsia occurring in the case of patients who are already hypertensive.

The incidence of eclampsia is about 1 in every 1,000 births. The maternal mortality rate in cases of eclampsia is about 5 per cent and the perinatal mortality at least 30 per cent. In countries where antenatal care is less well developed than in this country the incidence of eclampsia tends to be still higher. Vigilance to prevent fits with their high mortality is essential at all times in pregnancy, labour and the early puerperium.

Before the onset of fits there may be symptoms, referable to the brain, eyes, and liver. It should be noted that it is only in the severe type of disease that symptoms arise at all. Until this stage is reached there are only signs. The symptoms are those of headache, spots before the eyes, flashes of light and difficulty in reading. Pathological changes in the liver may cause pain in the right hypochondrium of a dull aching kind. Other pathological changes in the kidney are responsible for the development of massive proteinuria together with oliguria. Jaundice may result from the liver pathology. (See p. 192.) Any of these changes in any pregnant woman should be viewed with anxiety, and especially in those women who have been under observation for any degree of pre-eclamptic toxæmia. In addition to the above symptoms and signs massive œdema of the face, hands, abdominal wall and legs may develop quite suddenly, and on boiling the urine it may become solid with its content of protein. Any one or all of these signs and symptoms are of serious prognostic significance. It will be realized that these are the changes of imminent eclampsia or fulminating pre-eclampsia. The appearance of fits completes the syndrome.

In essentials the fits of eclampsia are similar to those of epilepsy. In the latter four stages are described namely, the aura, the cry, the tonic and clonic stages. The aura may be auditory, visual, gustatory and so on. In eclampsia there is no proper aura unless the flashes of light or spots before the eyes may be so counted. Nor is there any cry. But the tonic and clonic stages are exactly the same as those which occur in epilepsy. During the tonic phase all muscles are in spasm. The patient may assume the opisthotonic position with the head violently pulled backwards and the erector spinæ muscle in such contraction that she is supported only on the points of the occiput and the heels. The muscles of respiration are also in spasm so that for a time no oxygen is taken in and the patient is in blue asphyxia. Such anoxia deprives the fœtus of its oxygen supply, and even if it does not die at this time it will be severely distressed. After a few minutes the tonic stage gives way to the clonic one, in which the muscles alternately relax and contract, the patient showing jerking movements of the whole

body. During this phase the tongue may be bitten. Gradually respiration is restored and the patient becomes pink again, and as the clonic stage passes off the patient sinks into coma. Unlike the common course in cases of epilepsy it is unusual for the patient to be incontinent of fæces or urine.

One of the horrifying things about eclampsia is that the patient may have recurrent fits. In the worst cases they may occur every few minutes and be virtually continuous. In others the fits may occur half hourly or hourly. Once there has been a fit there is danger of recurrence until about 48 hours after delivery. When fits come on rapidly one after another the woman may die of asphyxia or from inhalation of vomit or from cerebral hæmorrhage, for the pressure in the cerebral veins under these conditions must be immense. Other causes of later death are total suppression of urine or massive necrosis of the liver.

TREATMENT OF ECLAMPSIA

The whole emphasis of this chapter has been on the prevention of eclampsia and the high maternal and fœtal mortality which result from this. Prevention of fits demands the greatest vigilance at all stages in pregnancy, labour and soon after labour. The means of prevention are medical, with the emphasis on sedatives and hypotensives, and surgical induction of labour or Cæsarean section. It is especially important to recognize cases of worsening toxæmia, imminent eclampsia and fulminating pre-eclampsia, so that they may be prevented from further development by abdominal delivery followed by full sedation for the next few days.

If eclampsia does occur then the aim must be to prevent further fits. There is definite evidence that the greater the number of fits the worse is the prognosis for the mother and baby. The methods available for treatment are essentially the same as those outlined for the treatment of pre-eclampsia. In eclampsia the nervous system is in a highly excitable state, and any stimulus may precipitate another fit, so that the excitability of the nervous system must be reduced by sedatives and anæsthesia, and everything done to cut down external stimuli, e.g. bright light, noise, rough handling and discomfort, arising especially from a full bladder or a strained position in bed. Also preparations must be made to prevent physical damage by violent movements and tongue biting during a fit, and to offset the effects of asphyxia as far as possible by the administration of oxygen. Also it may be helpful to lower the blood pressure by hypotensive agents and sometimes by venesection. In addition, since the patient is in coma or under the influence of powerful sedatives, there are dangers arising from hypostatic pneumonia so the patient must be turned frequently from side to side and given antibiotics. The complication of oliguria and anuria must be assiduously watched for and treated as soon as it is recognized.

Obstetric treatment is directed to delivering the patient at the most suitable opportunity. Quite often the patient will go into labour spontaneously. Because of the coma and drugs she has been given the patient will not be able to say that she is in labour, but the fact that she is in labour is easily recognized by the attendant because the patient becomes restless even under the heavy sedation and the uterus may be felt to be contracting during the times of restlessness. These pains may trigger off another fit and so the sedation may have to be increased, and now analgesics should also be administered. As in normal labour the analgesic most often used will be pethidine in 100 to 150 mg. doses as the case requires. If the woman does not go into labour spontaneously it is usual to rupture the membranes 24 hours after the fits have been controlled. To do so earlier tends to precipitate a fit. The surgical induction may be done under the sedation that the patient is already receiving, and may be performed where she lies in her bed so that she is not unnecessarily moved. If it is thought necessary so to remove her, it is well that she should be anæsthetized in her bed and taken to the place for operation under the influence of anæsthesia. Almost invariably the patient goes into labour shortly after the rupture of the membranes. Labour must be supervised carefully with full attention to sedation and analgesia. Bearing down in the second stage of labour is potentially dangerous and therefore should be curtailed by performing forceps delivery in the majority of cases. Ergometrine should not be given routinely for reasons mentioned before. Usually it will be best to perform the forceps operation under general anæsthesia, but if the previous sedation and analgesia have been heavy enough it may be reasonable to use regional or local anæsthesia.

Cæsarean section is seldom used in treatment after the patient has had an eclamptic fit, because in the past it has been found to be associated with a higher incidence of maternal death than conservative treatment practised alone. However it does have a place in the rare cases where the fits are quite uncontrollable by medical means. In such cases the patient may very well die if left undelivered and although Cæsarean section carries risks these are probably less than those of continuing conservative therapy. After such abdominal delivery the severity of the eclampsia usually declines. In addition Cæsarean section may have to be undertaken if there are other obstetric reasons for its performance such as disproportion. If such is the case it is best to delay the operation until about 24 hours after the last fit.

Details of treatment in eclampsia

Sedation. The actual methods of sedation are relatively unimportant. The aim is to keep the patient asleep for most of the time. The original method promulgated by Stroganov in Russia in 1900, and which

revolutionized the management and diminished the mortality, was by morphine injections and chloral hydrate per rectum. The dosage was varied to meet the needs of the case. Before Stroganov's time the treatment had been by forcible delivery through a cervix which had been manually dilated (accouchement forcé) or by Cæsarean section and this was associated, as might be expected, with an appalling mortality for both mother and baby.

More recently other methods of heavy sedation have been employed. Perhaps the simplest is to use various combinations of amylobarbitone by mouth together with injections of paraldehyde as needed. Tribromethanol (see p. 182) is also of great value, as it is in imminent eclampsia. Sodium thiopentone intravenously has also been used. An initial dose of 0·5 G. is given followed by an intravenous drip of 3 G. thiopentone in 1 litre of 5 or 10 per cent glucose solution. The drip rate is varied to suit the needs of the situation and should be supervised by a competent anæsthetist.

Hypotensive Drugs. These agents are usually only used when the blood pressure is of the order of 120 mm. diastolic. The intention is to prevent cerebral hæmorrhage. Any blood pressure reducing agent with which the attendant is familiar may be used but the one most often advocated is one of the veratrum group. Although these drugs are potentially dangerous the disease requires drastic measures. Veratrone is given in doses of 0·6 ml. intramuscularly every 15 minutes until the blood pressure drops to 120 mm. systolic or until the pulse rate is lowered to 60 per minute. During the administration of the drug the doctor must stay with the patient all the time and record the blood pressure and pulse rate every 5 minutes at the most.

Adjuvant and alternative methods. A variant of the method of sedation is the so-called 'lytic cocktail', which consists of a mixture of chlorpromazine and promethazine and pethidine. In one series of patients chlorpromazine has been combined with hypothermia, but for these methods more advanced textbooks should be consulted.

As well as deep sedation many obstetricians have used methods calculated to reduce cerebral œdema. The most time-honoured system has been to give magnesium sulphate per rectum, when by osmosis fluid is attracted into the gut and voided. This probably has little to recommend it. However there is no doubt that magnesium ions reduce the irritability of the nervous system and so magnesium sulphate is often given parenterally for this effect. 10 ml. of a 50 per cent solution can be given intramuscularly followed by 5 ml. 6-hourly for 24 hours. Such injections can only be given to a very well sedated patient because they are painful.

Another method calculated to reduce cerebral œdema is the intravenous injection by drip of half a litre of 50 per cent glucose solution.

In bad cases the blood pressure may be reduced and cerebral œdema diminished by venesection with the rapid removal of one pint of blood. This is rarely needed.

Nursing care. Good nursing of these cases is essential and the nurses will make many of the routine observations and be responsible for the proper keeping of the records on which so much depends in the proper management of the patient.

Prevention of pneumonia is aided by turning the patient from side to side every 2 hours, and the foot end of the bed is best raised a little to help any respiratory secretions to drain into the mouth. If the patient vomits the pharynx should be sucked out by mechanical sucker, with only rubber or plastic on the end put into the mouth. It is very important in the comatose patient not to allow foreign material to gravitate into the bronchi.

During the fit a gag should be put between the teeth to prevent the tongue being bitten. The gag is best made of a wooden tongue depressor with cotton wool and bandage wrapped round it to a thickness of about one inch so that teeth will not be broken on a hard surface. Of course any false teeth should be removed as soon as the patient comes under observation.

After the fit the airway must be seen to be clear and to make sure of this the tongue may have to be pulled forward by holding it between finger and thumb over gauze. Alternatively, to avoid being bitten, a tongue forceps may be used but this is undesirable. Oxygen should be administered as soon as possible after the fit is over. General anæsthesia may be needed at any time if the fits are coming frequently and for some manipulations such as rupturing the membranes, for delivery or even for the passage of a catheter. An anæsthetist should therefore be instantly available at all times.

A catheter should be passed with full sterile precautions as soon as the patient is sufficiently sedated. The object of this is to prevent the discomfort of a full bladder which may easily trigger off another fit. As with all indwelling catheters it is best if tubing conveys the urine to a sterile bottle with antiseptic in it under the bed. The tubing should be long enough to allow movement of the patient without disturbance. Another reason for catheterization is that a major complication of eclampsia is oliguria and anuria, so a most careful watch on urinary output must be kept and the contents of the urine bottle must be emptied, tested for protein, measured and stored for further investigation if need be.

An indwelling catheter is inevitably a potential source of infection and this risk is to be minimized by giving antibiotics. Perhaps the best is a mixture of penicillin and streptomycin, and besides combating urinary infection thus will also be valuable in the prevention of pneumonia.

External stimuli should be diminished and to this end the room should

be darkened, all attendants should walk quietly and carefully and those who are with the patient much of the time should have their shoes muffled or wear slippers. Talking near the bedside should be in whispers. All manipulations, e.g. turning the patient, catheterizing, or treating pressure areas should only be done with the woman well sedated. Enemas in general are not necessary. A full bowel can rarely be a cause of serious discomfort in an eclamptic patient and this is not a reason for the administration of an enema.

Remote prognosis in pre-eclamptic toxæmia and eclampsia

In a pregnancy subsequent to one in which the patient has suffered from some variety of toxæmia there is an increased risk of developing the condition again. (See p. 175.) Yet it is surprising that many women who have had serious disease in one pregnancy never have any toxæmic troubles in later ones.

After a bout of pre-eclamptic toxæmia perhaps about one-third of the women will have residual hypertension, but even in these the hypertension will diminish over the course of some years. The question arises as to whether the toxæmia is the cause of the hypertension. This is not easy to answer, but at the present time it is thought that those who have such residual hypertension would have developed it in any case whether they had ever been pregnant or not, and that the stress of pregnancy has only unmasked this tendency to hypertension. The evidence for this view is that the incidence of hypertension and of deaths from cardio-vascular disease are the same at all ages in both nulliparous women and those who have borne children. It would therefore seem that pregnancy is not a factor in causing hypertension. Moreover there have been a few cases of identical twin women, one of whom has had a baby with a toxæmic pregnancy and one of whom has remained nulliparous, and yet both have developed an almost similar degree of hypertension in the forties.

There is no evidence that toxæmia of any severity is a cause of permanent renal damage or liver damage. Therefore in general it is at present concluded that the ill-effects of pre-eclamptic toxæmia and of eclampsia are limited to pregnancy and shortly thereafter.

The largest and most serious problem of toxæmia is the high loss of fœtal and neonatal life. Loss of maternal life is relatively rare since eclampsia is a preventable disease and its incidence is low, though it could be lower. Pre-eclamptic toxæmia is now the major problem rather than eclampsia, and it is here that much progress remains to be made.

PATHOLOGY AND ÆTIOLOGY OF ECLAMPSIA AND PRE-ECLAMPSIA

Eclampsia. Morbid anatomy

IT is fortunately uncommon nowadays to be able to study the post-mortem features of eclampsia, but knowledge of them is necessary for a full understanding of the natural history of the disease. The organs most obviously involved in eclampsia are the brain, the liver and the kidneys. The cerebral lesions may be correlated with the signs and symptoms of headache and coma as well as the flashes of light, the hepatic lesions may be correlated with the epigastric pain and jaundice, and the renal lesions with proteinuria and oliguria.

Cerebral lesions. The brain shows œdema, and multiple small hæmorrhages scattered throughout its substance. Because of the rise in intracranial pressure the convolutions are flattened. Sometimes the hæmorrhages are confluent and massive hæmorrhage in any part of the brain may be the cause of death. Hæmorrhage and œdema may also be demonstrated in the retina.

Hepatic lesions. The lesions found in the liver in eclampsia are completely diagnostic of the disease. There is no other disorder which produces similar changes. Macroscopically the liver is enlarged and there are patchy red and yellow areas, of which the red are caused by hæmorrhage and the yellow by necrosis of the liver cells. The red and yellow patches are visible under the hepatic capsule and throughout the cut surface. On microscopic section the hæmorrhages are mainly grouped round the portal canals, but they may be so extensive that they completely disrupt the liver architecture. By interrupting the blood supply of the lobules they cause necrosis with fatty change, which is responsible for the yellow colour. The extravasated blood shows many fibrinous thrombi.

The epigastric pain which may occur in eclampsia probably arises from distension of the liver capsule. The interference with liver function is caused by destruction and damage to liver cells, and if this is severe it will result in jaundice. This is therefore a very serious sign. The damage to the liver may be so great that death occurs from hepatic failure.

Renal lesions. The primary renal lesion is in the glomeruli, which show swelling of their cells and of the underlying basement membrane. The whole glomerulus appears to be so stuffed with its own swollen cells that it looks as if there is no room for blood to flow through its capillaries,

although in fact a greatly diminished flow continues. Beyond the glomerulus the rest of the nephron which is supplied by the afferent arteriole is starved of oxygen. The result is necrosis of the proximal and distal convoluted tubules. This may be of any degree of severity from simple cloudy swelling up to death. Depending on varying circumstances, large or small areas of the kidney may be involved, with varying effects on the degree of failure of renal function. In extreme cases the cortex of the kidney may be destroyed almost entirely, the condition of *bilateral cortical necrosis.* This is unusual and is most frequently seen in cases of accidental hæmorrhage, when the degree of ischæmia may be extreme. In eclampsia the ischæmia is usually less severe and causes areas of patchy necrosis which may mainly affect the tubules rather than the glomeruli. This *lower nephron necrosis* may be reversible so that the patient may recover. Whether the glomeruli or the tubules are chiefly affected, there is always some degree of renal failure which may progress to anuria and death.

These pathological changes produce the proteinuria by damage to the glomerular cells, and the oliguria because glomerular filtration is greatly reduced and large areas of the kidney may be out of action. Lesser degrees of renal failure are due to impairment of the function of the convoluted tubules. The amount of glomerular filtrate may be very little diminished but the tubules are incapable of concentrating the fluid which reaches them.

Ætiology of late toxæmia of pregnancy

There are many theories of the cause of late toxæmia of pregnancy. None is entirely satisfactory. To be acceptable any theory must explain certain clinical facts about the disorder among which are these:

1. It occurs more commonly in first than in subsequent pregnancies.
2. It has a high incidence when there is pre-existing hypertension or chronic renal disease.
3. It does not always recur in subsequent pregnancies.
4. In some cases it appears to be reversible, or its rate of progress may be slowed down.
5. It is common in twin pregnancies.
6. It is common in women who have diabetes mellitus.
7. It occurs frequently in cases of hydatidiform mole. The presence of a fœtus is therefore not essential for its development.
8. It may occur in cases of fœtal hæmolytic disease, but only in those with a hydropic fœtus and placenta.
9. It may occur for the first time after delivery and may then be severe enough to progress to eclampsia. Again the presence of the fœtus and even of the placenta do not seem to be essential for its development.

7

The pathogenesis of hypertension in pre-eclampsia

Any theory of aetiology must explain the hypertension of late toxæmia. The blood pressure is the resultant of the cardiac output and the peripheral resistance. In normal pregnancy the blood pressure tends to fall in the middle trimester although the cardiac output stays the same or increases; therefore the peripheral resistance must be decreased. It is conjectured that the main decrease in resistance is in the blood vessels of the pelvis, and some regard the placental site as a variety of arterio-venous shunt. It is known too that the vessels of the skin are relatively dilated, a fact clinically demonstrated by the pregnant woman's indifference to cold. Later in pregnancy, and especially in the last four weeks, the blood pressure tends to rise again as the cardiac output is falling. Therefore at this time the peripheral resistance is rising, but the reason for this is not known. There are no accurate data on cardiac output and peripheral resistance in pre-eclamptic toxæmia but the increasing peripheral resistance of normal pregnancy appears to be exaggerated and to come on earlier in toxæmia.

The peripheral resistance depends on arteriolar tone which varies in different parts of the body at different times according to the degree of physiological function of the part. The clinical measurement of the blood pressure made by sphygmomanometry is the resultant of all the varied peripheral resistances. It is important to realize this, for the blood pressure reading is of the general pressure within the larger vessels and does not give information about the intimate circulation in any organ or part. For instance, the arteriolar tone may be high in the liver and unchanged in the kidney. The degree of post-mortem changes in the liver and kidney and brain are very variable. Proteinuria is sometimes the only evidence of pre-eclamptic toxæmia. In the case in which there is hypertension as recorded in the arm there is presumably generalized arteriolar constriction, but sometimes such arteriolar responses may be restricted to only a few organs and rarely only to one. The variability of vascular response is the basis for the varied clinical picture seen in pre-eclamptic toxæmia. The post-mortem changes of eclampsia may all be explained by widespread vascular spasm.

One of the earliest theories of aetiology was based on the erroneous belief that *infarction of the placenta* was more frequently seen in this disorder than in other cases. It was thought that these infarcts during their disintegration produced toxins which acted to cause widespread vascular spasm. There is no direct evidence that this occurs, nor is it a fact that such infarcts are any commoner in toxæmic than in normal pregnancies. It is more likely that placental infarcts are the result of constriction in the vessels supplying the placental site rather than a cause of widespread arteriolar spasm.

More recently it has been suggested that relative *ischæmia of the uterus and placenta* may cause the release of chemical substances, analogous to those produced by the ischæmic kidney, which cause an increase in vascular tone. This theory would explain the increased incidence of hypertension in first pregnancies, with twins, with hydramnios, and with concealed accidental hæmorrhage, in all of which there may be increased tension in the wall of the uterus. It can be shown that the absorption of sodium isotopes from the uterine wall is reduced in cases of toxæmia, and that the relative blood flow is increased if the patient is put at rest.

Recently other products of the placenta have been investigated as possible causes of pre-eclampsia, and attention has mainly centred round enzymes and especially *mono-amine oxidase.* This destroys adrenaline and similar compounds and its presence in the placenta is thought to be a protective mechanism, for these chemical substances may cause contraction of the uterine arteries and diminish the blood flow to the placenta. Moreover adrenaline has harmful effects on the fœtus and mono-amine oxidase in the placenta may prevent it reaching the fœtus in dangerous concentrations. There is some evidence that the concentration of mono-amine oxidase in the placenta is diminished in pre-eclampsia, so the theory is that adrenaline or something similar may then have a greater effect on the uterine blood flow than in normal pregnancy. Just as the ischæmic kidney produces renin to maintain the blood flow to itself it is suggested that the uterus or placenta may produce some hormone which raises the blood pressure. This is not proven and moreover anti-adrenaline drugs have no effect on the course of pre-eclampsia, but it is too early to pronounce any judgement on the theory.

Another theory suggests that there is a *utero-renal reflex* so that when the uterine tone is high, or if the uterus is stimulated by such events as accidental hæmorrhage, then reflex vascular spasm occurs in the kidney. Renal ischæmia would then call into play the well-known renin-angiotensin mechanisms. There is experimental evidence that in animals undue distension of the uterus does cause renal ischæmia. It must be said that there is no consistent clinical evidence of increased uterine tone in cases of toxæmia, but the utero-renal reflex almost certainly plays a part in the cortical renal necrosis which occurs in some cases of severe concealed accidental hæmorrhage.

Other humoral agents than those arising from the uterus or kidneys have been in invoked in ætiology. Suspicion has fallen on the secretions of the *anterior and posterior lobes of the pituitary gland, the adrenal glands and on the endocrine secretions of the placenta.* There is as yet no evidence to incriminate any of the trophic hormones of the anterior lobe of the pituitary, though the diabetogenic hormone has been suggested as having a role in the ætiology of the toxæmia which occurs frequently in diabetes mellitus.

Vasopressin of the posterior lobe of the pituitary gland is a known hypertensive agent, but even its normal physiological rôle is far from clear and efforts to demonstrate it in the blood of toxæmic patients have failed. The antidiuretic hormone could possibly be one factor in the retention of fluid that is seen in many cases of toxæmia but it is not known to have a direct effect on vascular tone, and reports about its presence in excess in cases of toxæmia are conflicting.

Aldosterone from the zona glomerulosa of the adrenal is secreted in very large amounts in pregnancy, and is probably responsible for the retention of sodium seen in all pregnancies. However present evidence suggests that the amount secreted falls in pre-eclamptic toxæmia as compared with normal pregnancy, but why this should be so is not known. Cortisol output is increased too and, since this plays a major part in Cushing's syndrome in which there is usually hypertension, it has been thought that it may be a cause of toxæmia. However there are no differences in blood concentrations of cortisol in normal and toxæmic pregnancy, and it is possible that the high concentrations in both types of pregnancy are physiologically inert since most of the cortisol is bound to the serum proteins.

Adrenaline and noradrenaline from the suprarenal medulla are hypertensive agents, but there is no evidence of them being involved in the hypertension of pre-eclamptic toxæmia.

At term the placenta produces virtually no chorionic gonadotrophin and, although its secretion of sex steroids is high, there is no difference to be found in the concentrations of these in normal and toxæmic pregnancy. In hydrops fœtalis chorionic gonadotrophin output is high and may have to be considered as having some part in the genesis of pre-eclampsia.

Since there has been no completely convincing explanation of the increase in arteriolar tone by the action of humoral agents a search for *neural factors* has been made. Various stimuli such as the application of cold to a limb may demonstrate that pre-eclamptic patients have an unduly reactive vascular system as shown by a larger rise in blood pressure than is seen in normal subjects. Even though this may be so it does not explain the agent which causes the nervous system to react in this fashion in toxæmia.

Surveys of diets have purported to implicate various deficiencies and excesses in the genesis of toxæmia, but none have yet been of help in understanding ætiology. There is no evidence that restricting protein intake will reduce the incidence of toxæmia.

Œdema

Œdema is due to an increase in the tissue fluid surrounding the cells. Such fluid is part of the total extracellular fluid, which consists of the

plasma together with the tissue fluid. The rest of the fluid of the body is intracellular fluid. In any area where excess tissue fluid collects, so causing œdema, the extra fluid could have been contributed from either the plasma, the cells or both.

Normally fluid flows out of the capillaries into the tissue fluid space because of the hydrostatic pressure at the arterial end of the capillary. From the tissue fluid nutrients and water pass through the cell wall to be used within the cell and then the waste products of metabolism are returned through the cell wall into the tissue fluid. At the arterial end of the capillary the hydrostatic pressure exceeds the protein osmotic pressure of the blood plasma, but at the venous end the hydrostatic pressure is less than the protein osmotic pressure. Because of this fluid flows out of the capillary into the tissue fluid at the arterial end but into the capillary from the tissue fluid at the venous end.

Œdema of the legs, so common in all pregnancies, is probably due to raised venous pressure, which in pregnancy is three times higher than in the non-pregnant woman. Such local areas of œdema probably always have local causes, but the œdema of pre-eclampsia is more widespread and is shown clinically in the legs, feet, hands and round the eyes. Theoretical consideration suggests that such extensive œdema might be due to increased extracellular fluid volume, to raised hydrostatic pressure at the arterial end of the capillaries, to damage to the capillary wall increasing permeability, to damage to the cell walls altering the rates of flow of fluid into and out of the cells, to increased osmotic pressure within the tissue fluid so holding water there, to diminished osmotic pressure of the plasma proteins or to raised venous pressure, and all these factors may need consideration.

The evidence for an increased extracellular fluid volume in pre-eclampsia in conflicting. Some believe that there is a relative excess of water, some that there is a relative excess of total sodium and some that there is an excess of both. All these notions have been contested. Water excess might be due to increased output of the antidiuretic hormone of the posterior lobe of the pituitary gland but this has not been convincingly demonstrated. Water might also be retained by altered renal function. In normal pregnancy a water load is not as easily excreted as in the non-pregnant woman, and the ability to handle such a load diminishes as the pregnancy nears term. In pre-eclampsia the glomerular filtration rate and the renal plasma flow are probably diminished as compared with normal pregnancy, but the reasons for this change are obscure. Perhaps they may be explained on the basis of increased arteriolar tone within the kidney, but as mentioned before the mechanism of this is not yet explained satisfactorily. Sodium retention is a feature of all pregnancies and the high output of aldosterone may be the reason for this. But the secretion of

aldosterone seems to be less in pre-eclampsia than in normal pregnancy and this fact is confusing. It is likely that the total quantity of sodium in the body in pre-eclampsia is greater than that found in normal pregnancy, but the evidence for this is conflicting too. More sodium may be held in the tissue spaces because the cell walls become in some way relatively imperme- able to the passage of sodium into them, or there may be some failure of the cells to pump sodium out.

That there is hypertension in nearly all cases of pre-eclampsia is not in doubt and so there may be an increased hydrostatic pressure at the arterial ends of the capillaries. But this is not proven, and, since hyper- tension depends on increased arteriolar tone and the arterioles are proximal to the capillaries, it is not certain that the hydrostatic pressure is transmitted to the capillaries.

The osmotic pressure of the proteins of the plasma is lowered in all pregnancies and usually there is no difference to be found in this pressure between normal and toxæmic pregnancy. Widespread damage to the capillary walls causing increased permeability is a theoretical possibility but no agent causing such a change has been found.

We may conclude that at present the œdema of pre-eclamptic toxæmia is as much an enigma as is the hypertension.

Proteinuria

Proteinuria must be due to damage to the glomeruli in the main. There is morbid anatomical evidence of this in the glomerular lesion of eclampsia, and similar swelling of the glomerular cells has been found by renal biopsy in cases of pre-eclampsia. The cause of the cellular swelling is probably the vascular spasm within the kidneys, the cause of the vascular change being unknown.

The rationale of treatment in pre-eclampsia

There is little more to discuss about the obstetric treatment of pre- eclampsia, consisting of induction of labour or Cæsarean section. These procedures are based on sound empirical grounds and have the purpose of securing the delivery of a viable baby before it dies in utero. The medical treatment, consisting of rest, sedation, hypotensive and diuretic drugs, deserves some further discussion.

Rest in bed lowers the cardiac output, partly by decreasing the pulse rate and partly by a fall in stroke volume. The peripheral resistance is also lowered because, particularly with sedation, impulses from the higher centres to the vaso-motor centre are reduced, and also because a reduction in the venous return has this effect. Lowering the peripheral resistance may reduce the blood pressure.

Another valuable aspect of bed rest is that it improves the blood supply to the uterus and placenta. Some evidence for this has come from experiments involving the injection of isotopes into the uterine wall, and noting the time for their absorption. If the results of these experiments are accepted then it would appear that in hypertension the uterine and placental blood flow is reduced to about one-third of its normal level of about 600 ml. per minute. Such a reduction could have drastic results on the nutrition and survival of the fœtus. It is well known that with severe essential hypertension the fœtus does not grow at the rate expected. Moreover similar experiments have shown that during exercise the uterine blood flow is decreased. Bed rest is therefore of value to the fœtus, by maintaining its supply of nutrients and especially oxygen. Also if the hypertension and reduced blood flow to the uterus in pre-eclampsia cause the production of some noxious humoral agent, its concentration should be diminished. A similar argument applies if the renin-angiotensin mechanism of the kidney is responsible for hypertension in pre-eclampsia, for it has been shown that the renal blood flow increases as a result of rest in bed.

Hypotensive agents act on the vasomotor centre or the sympathetic centre in the hypothalamus, on sympathetic ganglia, or directly on the arterial walls. Virtually all the hypotensive drugs used in pre-eclampsia and eclampsia have their main action on the nervous system, so that if the main cause of hypertension is in fact humoral rather than neural they can only be of indirect or partial benefit. There is no evidence that they increase the uterine blood flow, and so far no striking improvement in the fœtal results has been shown from their use.

Œdema decreases with bed rest. Although in sleep the urinary output is diminished, during continued rest in the recumbent position the output is increased and excess water is excreted. This is valuable for it can be shown that even in normal pregnancy the kidneys have difficulty in excreting an administered water load, and that this inability increases as term approaches. The basis of the diuretic effect of rest is an increase in renal blood flow and an increase in the glomerular filtration rate. In the recumbent position the venous pressure in the legs is also reduced and water moves from the legs to the sacral area. Posture has been shown to be a significant factor in diuresis, for pregnant women who lie on their sides excrete more water and salt than those who lie on their backs. It is probable that this is because the pregnant uterus may compress the inferior vena cava and the renal veins in the supine but not in the lateral position. The resulting increased venous pressure in the kidney will impair function by diminishing renal blood flow.

Water and sodium are excreted together. Sodium excretion is needed in these circumstances to preserve the total body osmotic relationships.

Conversely, loss of sodium caused by the administration of such substances as chlorothiazide, which affect tubular reabsorption, also helps to remove water. The role of œdema in the genesis of pre-eclampsia is obscure. It seems to be a symptom of the underlying disease rather than in any way contributing to the cause of it. Nevertheless it seems sensible to keep it within reasonable bounds, and if it should be shown that sodium retention can really be implicated in the ætiology of the disease then sodium diuresis is obviously desirable.

ESSENTIAL HYPERTENSION
CHRONIC NEPHRITIS

ESSENTIAL HYPERTENSION

PRE-ECLAMPSIA is the commonest cause of hypertension during pregnancy and this disorder usually occurs during the last 10 weeks of pregnancy, but some patients have a blood pressure of 140/90 mm. or more before this time without any other physical signs. Such patients are usually classified as cases of essential hypertension, but they are very likely to develop pre-eclamptic toxaemia with the addition of the signs of œdema or proteinuria, and with the risk of eclampsia or of fœtal death. A raised blood pressure at any time in pregnancy is a matter of serious significance. As with pre-eclamptic toxaemia the blood pressure is deemed to be raised when it is 140 / 90 mm. or above. To take the standard at any lower point is impracticable as it includes too many women in the category of hypertension.

Diagnosis of essential hypertension

If the blood pressure is consistently raised in the first 24 weeks of pregnancy there is little doubt about the diagnosis. It is important to be sure that the blood pressure is truly raised by recording it after adequate rest and in the recumbent position. As we mentioned in the chapter on toxaemia of pregnancy some patients will have a raised blood pressure because of anxiety, and these nervous women are said to have a labile blood pressure. If several successive readings are taken on these patients they will be found to vary considerably. Even though these women may not be labelled as hypertensive they should be observed closely, as patients with such labile pressures are more prone than others to develop hypertension eventually.

If the patient first presents herself to the antenatal clinic after the 28th week of pregnancy and is then found to have a raised blood pressure it is not possible to say whether she is a case of essential hypertension or whether she is in the early phase of pre-eclamptic toxaemia. If she later develops either œdema or proteinuria it is possible to say that she has pre-eclamptic toxaemia but it still cannot be known whether this is on the basis of a pre-existing essential hypertension. Only prolonged follow-up in the time after the pregnancy can determine this. Also if the woman

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first comes to the antenatal clinic in mid-pregnancy and has a normal blood pressure it is not certain that she does not have hypertension, for hypertensive patients are subject to the same drop in blood pressure during the middle trimester of pregnancy as normal patients (p. 171). Thus a woman whose true non-pregnant blood pressure is 140/90 mm. may have one of only 120/80 mm. at 28 weeks. It will be seen that the diagnosis of essential hypertension in pregnancy is far from easy to make, but this does not prevent adequate management which is on lines similar to those for pre-eclamptic toxæmia, which is a common sequel to underlying hypertension.

Patients with essential hypertension often have a family history of this disease, and this is a useful clue in diagnosis.

If hypertension is found an effort must always be made to discover any underlying cause such as chronic nephritis (p. 206), chronic pyelonephritis (p. 256), polycystic disease of the kidneys, coarctation of the aorta, or phæchromocytoma (p. 291). The femoral pulses should always be palpated in cases of hypertension; absence of pulsation would suggest the possibility of coarctation of the aorta. The urine should be examined for protein and casts, and bacteriologically examined if any pus cells are found. The blood urea may be estimated, and sometimes other renal function tests are carried out.

Proteinuria is a finding of serious prognostic significance when found with hypertension, for it implies both renal and cardiovascular disease. Which of these is primary is not of immediate importance in obstetric practice, and fortunately most cases of essential hypertension have not progressed far enough to cause renal damage during the childbearing years. However, proteinuria may be due to chronic nephritis, chronic pyelonephritis, or to relatively rare diseases such as disseminated lupus erythematosus involving the kidney. This may be diagnosed from the discovery of L.E. cells in the blood.

The retina should be examined in all patients with hypertension, looking especially for nipping of the veins where they are crossed by the arteries, for narrowing of the arteries, and occasionally for hæmorrhages or exudate. Such findings may show that the hypertensive disease is of long standing and probably preceded the pregnancy.

Management of essential hypertension

If the blood pressure is of the order of 140/90 mm. in the first 24 weeks of pregnancy the patient should be seen weekly and the appropriate investigations made. If the blood pressure stays at this level nothing more than careful observation is needed though any rise should be the signa for admission to hospital, and this should also be done if œdema or

proteinuria supervene, and the treatment then becomes that of pre-eclamptic toxæmia. In any case where the blood pressure is still at this height at the 36th week of pregnancy the patient should also be admitted.

Even with this mild variety of hypertension efforts may be made to lower the blood pressure to safer levels. At first it is usual to try the effects of barbiturates, especially if the patient is of the nervous kind. Phenobarbitone in doses of 30 to 60 mg. ($\frac{1}{2}$ or 1 gr.) twice or three times daily is perhaps the best. A mild hypotensive such as reserpine is often valuable. It is given in doses of 0·25 mg. twice daily and may be cautiously raised to 0·5 mg. three times daily depending upon the response of the blood pressure. If more powerful hypotensives are needed the patient should be admitted to hospital where she can be under continuous observation. Reserpine usually has a calming influence as well as a slight though specific effect on lowering the blood pressure. It may, however, cause depression which at times may be quite severe, and in these circumstances the drug should be stopped. Chlorothiazide also seems to have a slight effect in lowering the blood pressure in addition to its diuretic effect. It may therefore be given in the usual dosage of 1 G. daily, especially towards the end of pregnancy, together with reserpine. The usual precautions to prevent hypokalæmia should be employed, namely to give potassium salts and also to give the drug for only five days out of every seven, though with care it may be given continuously.

When the diastolic pressure is 95 mm. or above, even in early pregnancy, the patient should be admitted to hospital to observe the therapeutic effect of rest, to make any appropriate investigations, especially renal and ophthalmoscopic, and to start hypotensive drugs if necessary. If hypertension of this degree is not controlled it is highly likely that the woman will develop pre-eclamptic toxæmia and there is a risk of intra-uterine death. Quite apart from fœtal death it is well known that with persistent hypertension the fœtus fails to grow at its proper rate, and the babies of hypertensive mothers are very often underweight for the length of the gestation. Indeed if the baby is of normal weight it is possible that the patient should not really have been included in the hypertensive category. However this is a matter that can only be decided after the baby is born, and does not affect the management in pregnancy. In the more extreme cases it is possible to tell that the fœtus is not growing as well as it ought to by the feel of the size of the baby and this may be partially confirmed by the failure of the fundus of the uterus to rise up the abdomen to the expected level. Some obstetricians lay store by measurements of the abdominal girth, but this is very inaccurate, and adds little to the clinical impression gained by palpation.

In hospital the effect of complete bed rest is first noted, whilst recording the blood pressure three or four times a day and during sleep if at all

possible. The rest may be aided by the administration of some barbiturate, usually phenobarbitone or amylobarbitone. Under fairly heavy sedation the blood pressure tends to fall especially in the nervous patients with labile hypertension. If such is the case the patient may sometimes be sent home on a maintenance dose of the appropriate barbiturate but she must be observed closely at least weekly in the antenatal clinic. When rest and barbiturates fail to have the desired effect a hypotensive drug may be tried but on the whole all the hypotensive drugs are disappointing in pregnancy. They may not influence the degree of hypertension at all, and even when the blood pressure is reduced to more normal levels it is not uncommon to find that the baby is still small and it may even die in utero. When this happens it is probable that although the systemic blood pressure has been reduced the hypotensive drug has had no effect on the blood flow in the uterus, and it is even possible that the reduction of the systemic blood pressure may diminish rather than increase the blood flow to the placenta. Nevertheless it is sometimes reasonable to carry out a therapeutic trial with one of these drugs.

Personal preference among the hypotensive drugs is at present for methyldopa in doses up to 4 G. daily. It is started at a dosage of 250 mg. twice daily and then slowly worked up towards the maximum dose depending on the response of the blood pressure. It has the special advantage that its effects are not dependent upon the patient standing up as it is with so many of the others. With some other drugs a hypotensive effect is only seen when the patient is on her feet and then the blood pressure may fall so precipitously that she feels faint.

Other hypotensive drugs which are in use are veratrum derivatives, hydrallazine ('Apresoline'), pentolinium, mecamylamine ('Inversine'), pempidine tartrate ('Perolysen'), bretylium tosylate ('Darenthin') and guanethidine sulphate ('Ismelin'). It is not proposed to go into the details of treatment with all these. Their use in pregnancy is similar to that in general medicine and they should be used with some caution. It must be repeated that the standards of hypertension applicable to general medical practice have virtually no relevance to obstetric practice, the standards of abnormality being far too high in general medicine for safe application to obstetrics. Moreover the fate of the foetus has to be kept constantly in mind.

Obstetric treatment in essential hypertension is exactly the same as for pre-eclamptic toxaemia. Indeed a fair number of those women with hypertension will develop toxaemia, as shown by oedema and proteinuria in addition to the raised blood pressure. Obstetric treatment is essentially that of securing delivery of the foetus at the best time to avoid serious complications to the mother and prevent foetal death. It has been computed that where the diastolic pressure is 90 mm. or more the perinatal loss will be about 7 per cent as compared with the loss in normal pregnancy of

about 2 per cent. If the systolic pressure is above 160 mm. the loss is doubled to about 13 per cent. When the blood pressure is regularly in the region of 170/100 mm. the fœtal loss is about 30 per cent. Much of this fœtal loss occurs in the last few weeks of pregnancy so that it is often best to secure delivery before term. The time for doing this will depend on the features of the particular case, but in general the higher the blood pressure the earlier should the delivery be. The method of delivery will also depend on individual features. In the milder case surgical induction of labour should be performed at the 38th week or earlier, and this may be aided by the use of the intravenous oxytocin drip as outlined in the chapter on toxæmia and in that on induction of labour. In an elderly primigravida, and such patients are particularly prone to suffer from hypertension because of age, it is often best to proceed straight to Cæsarean section. As with pre-eclamptic toxæmia this should be done if the surgical induction of labour fails, because if it has been decided that the fœtus is at risk because of the hypertension then it is even more at risk when the membranes have been ruptured and she is not in labour. The risks are those of anoxia and infection. Anoxia is particularly important since it is probable that when there is hypertension the blood flow to the placenta is diminished and so the fœtus is already partially anoxic before surgical induction is done. The reduction in the volume of the uterus by allowing liquor to escape probably increases the tone of the uterine muscle and this in its turn is liable to reduce the uterine and placental blood flow still further.

Because there is about a 30 per cent risk of fœtal death when the blood pressure early in pregnancy is of the order of 170/100 mm. termination of the pregnancy may have to be considered, and this should often be combined with sterilization. Everything depends on the individual features of the case. If a woman has already had three or more children, and particularly if she has been brought near to disaster previously on account of the hypertension or its complications, the case for termination and sterilization is fairly strong. With an elderly primigravida, on the other hand, everything should be done to get her safely through this pregnancy. This may necessitate rest in bed in hospital throughout the whole of the pregnancy together with massive doses of hypotensive drugs, but such a patient will frequently submit to such a régime without demur, whereas another woman with children at home to be cared for would find it extremely irksome and in fact might refuse to come into hospital with consequent serious danger to herself and her unborn child. Obviously the case for termination is stronger the higher the blood pressure. The matter of termination is not one for dogma. It should not be pressed on those who are unwilling for it to be done, and equally those doctors who have religious objections to termination should state this plainly to the patient and send her to someone else if the patient so wishes, after they have

explained that in cases such as this there may be honest differences of opinion on the best course to pursue.

Accidental hæmorrhage in hypertension in pregnancy

For a full account of accidental hæmorrhage see page 447. Many obstetricians believe that hypertension of any kind whether it is essential, dependent on renal disease or due to pre-eclamptic toxæmia may be a cause of the serious catastrophe of accidental hæmorrhage. This view is not supported here because accidental hæmorrhage seems to be no commoner in those with proven hypertension than in normal pregnancy. Moreover in over 90 per cent of those women who do have an accidental hæmorrhage there has been no previous indication of any rise in the blood pressure. This does not completely exclude the possibility that such patients did in fact have a sudden rise in the blood pressure just prior to the tearing of the placenta off the uterine wall, yet if that was the case it might be expected that some previous indication of lability of the blood pressure would have been shown in at least some of these cases, but this is not so.

There is no doubt that in many cases of accidental hæmorrhage when first seen there is a rise of blood pressure of the order of 90 to 95 mm. diastolic. Some have suggested that this is because the blood pressure at the time of the separation of the placenta was considerably higher and has been reduced to this lower level by the blood loss. However the opinion held here is that the blood pressure rise is a cardio-vascular reflex response to the loss of blood such as is often seen after other hæmorrhages when the total amount of loss is neither too slight nor too great. There is evidence that in accidental hæmorrhage the cardiovascular reflex responses are unusual, for it is common to find a pulse rate of about 80 or 90 per minute after a large loss of blood: in any other condition with such a blood loss a pulse rate more in the region of 120 or 130 per minute might reasonably be expected.

In most cases of accidental hæmorrhage there is proteinuria, which is not usually heavy. In the past this has been attributed to toxæmia. Here it is held that it is more likely to be just a result of the blood loss, for proteinuria may be found in such conditions as gastro-intestinal hæmorrhage.

It cannot be said with certainty that hypertension never causes accidental hæmorrhage, but the evidence that it does is far less strong than it used to appear, and so it is not included as heretofore in this book as a complication of hypertension.

NEPHRITIS

There have been many classifications of chronic nephritis but the niceties of these are not of importance in practical obstetrics. For the present it is

sufficient to outline two types, following Ellis's classification. In *Type I* the onset is acute with gross hæmaturia, some œdema, albuminuria and slight hypertension. The disease often follows an acute infection of the upper respiratory tract. This type of nephritis is most apt to occur in those under the age of 20, and 85 per cent of the patients recover completely, so that any subsequent pregnancy is uneventful. If complete recovery does not occur the patient has residual hypertension, often with little protein-uria. The hypertension may eventually cause renal damage, but often only after a long span of years. In *Type II* nephritis the onset is more insidious and the outstanding feature is gross albuminuria with œdema. It has no special predeliction for any age group. In this type of nephritis the lesion is slowly progressive over several years, but usually ends in death from uræmia or hypertension. However, there is great variation in the course of the disease. It will be realized that *Type II* nephritis is the one mainly giving rise to serious problems in obstetrics.

Acute *Type I* nephritis during pregnancy is very rare. It usually responds to the same treatment that would be employed in the non-pregnant patient, that is rest in bed, penicillin, and nothing by mouth except glucose drinks. The intake of fluid is restricted to 600 ml. daily plus a volume of fluid equi-valent to the amount of urine passed the precious day. This avoids over-loading with fluid and is designed to replace the fluid loss due to insensible perspiration together with that in the urine. Once diuresis sets in the patient is slowly returned to a normal diet and fluid intake. Only if the disease during pregnancy does not respond well within two weeks should it be necessary to consider termination of pregnancy, and since it is not believed that the pregnancy contributes to making the acute disease become chronic this is seldom justified.

The more usual problem presenting itself to the obstetrician is that of mild Ellis *Type II* nephritis. (In the later progressive stages of the disease with evidence of renal failure the patient is usually too ill to become pregnant.) The only sign is that of massive albuminuria. A result of this may be lowering of the plasma proteins and these should be estimated at intervals during pregnancy. The blood urea is not raised and urea clearance tests and water concentration and dilution tests are within normal limits. Hypertension at least in early pregnancy is not a feature. However there is no doubt that these patients have an increased liability to develop pre-eclamptic toxæmia and so a careful watch for this complication must be kept. If toxæmia does occur it is treated on the usual lines. If hypertension is not superimposed on the renal disease the outlook for fœtal survival is good and about 90 per cent of the babies should live. If there is hyper-tension, and this may occur in as many as 75 per cent of the cases the fœtal mortality is in the region of 33 per cent.

Because of the high fœtal loss, and this is added to by the tendency

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to abortion, the question of termination of pregnancy is less unacceptable. As in cases of hypertension this is a matter to be judged in the light of the features of each individual case. If a woman already has children, since there is the possibility that the pregnancy may cause further renal damage and so shorten her life, there may be a good case to be made for termination and sterilization. Otherwise it is usually better to allow her to carry on with the pregnancy and be under the care of both the physician and obstetrician. In most cases it is best to discuss the whole situation with both the patient and her husband; there are so many personal and social factors involved that no hard and fast rules can be laid down.

If it is decided to continue with the pregnancy renal function should be assessed as far as possible and the treatment is rest, with a high protein diet to offset the loss in the urine, and salt restriction to prevent œdema. Casilan is a useful preparation for supplementing the usual dietary proteins and in a few cases ion-exchange resins such as Katonium may be administered to reduce the sodium load. Corticosteroids such as prednisolone are also used in consultation with the physician. If corticosteroids are decided upon it should be remembered that they suppress the normal output from the adrenal and therefore the patient has no reserves to call upon to tide her over the stresses of labour. She will therefore require supplementary doses, probably of hydrocortisone, at this time.

OTHER RENAL LESIONS

Polycystic disease of the kidneys

A few patients with this congenital disease of the kidneys present when pregnant. The problems are exactly the same as those of chronic nephritis. Everything depends on the degree of renal failure, if any, and any superadded hypertension. Just as in cases of nephritis there is an increased tendency to pre-eclamptic toxæmia, and if this occurs it should be treated on the lines already laid down for that disease. The question of termination of pregnancy is dealt with on the lines discussed under chronic nephritis.

Renal tuberculosis

Renal tuberculosis offers no special problems to the obstetrician except those of diagnosis. It is rarely severe enough during pregnancy to cause any serious impairment of renal function or any hypertension. It is treated in the usual way with anti-tuberculous drugs, and the period of follow-up must be prolonged.

Chronic pyelonephritis

Chronic pyelonephritis is dealt with elsewhere (p. 256). Its importance in the present context is in differential diagnosis. It is the most common of all diseases affecting the kidney which occur in pregnancy and so must

be rigorously sought for in all disorders in which the kidney might be involved, and in cases of hypertension. It is disastrous to miss the diagnosis because the disease is treatable, and if it is properly treated the incidence of hypertension, pre-eclamptic toxæmia and chronic renal disease, with all their baneful effects both during pregnancy and after, may be reduced.

Lupus erythematosus

Disseminated lupus erythematosus affecting the kidney during pregnancy is dealt with on the same general lines as given for chronic nephritis. Its course in pregnancy is unpredictable. Hypertension may develop and there is always proteinuria. It is therefore a differential diagnosis from chronic nephritis. Treatment is with adrenal corticosteroids or their derivatives. Pregnancy is managed according to the course of the disease with special reference to any signs of renal failure and of hypertension.

Previous nephrectomy

If the remaining kidney is completely normal there need be no concern during pregnancy.

VOMITING DURING PREGNANCY

NAUSEA or slight vomiting occurs in almost 50 per cent of women in normal early pregnancy, being more frequent in primigravidæ than in multiparæ. Very rarely the vomiting may be more severe and in the most exceptional cases the life of the patient may be endangered. The causes of vomiting in pregnancy may be classified as follows:

1. Vomiting due to a disease complicating pregnancy, e.g. pyelitis, hiatus hernia, intestinal obstruction, acute appendicitis, hepatic necrosis.
2. Early morning sickness.
3. Hyperemesis gravidarum.

Vomiting due to diseases complicating pregnancy

Vomiting in pregnancy may be due to a disease which may be looked upon as an incidental complication of, and not the result of, pregnancy, such as that due to the onset of an acute specific fever, to gastritis, to pyelitis, or to a cerebral tumour. A peptic ulcer very rarely causes symptoms during pregnancy, perhaps because of a fall in gastric acidity. Care must be taken not to pass over a case in which the vomiting is the result of appendicitis or intestinal obstruction.

One cause of heartburn and vomiting, especially in the later weeks of pregnancy, is a diaphragmatic hiatus hernia as a result of the increase in abdominal contents. The hernia can be demonstrated by a barium meal X-ray examination; it shows part of the stomach entering the chest through the œsophageal hiatus. It gives rise to heartburn because regurgitation of stomach contents occurs, and relief may be obtained with alkalies. The patient is advised to sleep propped up in bed with pillows and reassured that the condition will usually give rise to no further trouble once the pregnancy is over.

Early morning sickness

This symptom, one of the earliest diagnostic criteria of pregnancy, comes on about the 6th week and consists of nausea on waking in the morning and the vomiting of the resting gastric juice. It may persist until the patient has vomited her breakfast but the condition improves later in the day. Some degree of nausea may persist throughout the day, but not sufficiently to prevent an adequate intake of food and fluid. The sickness disappears about the 14th week. For treatment see page 215.

Hyperemesis gravidarum

The early nausea and vomiting of pregnancy usually subside by the 14th week. Sometimes, however, the symptoms are much more severe and the vomiting persists. All gradations occur from the mild cases of ordinary morning sickness to vomiting which is so persistent and severe that it imperils the patient's life. The term hyperemesis gravidarum is applied to those cases in which the vomiting becomes so frequent that it interrupts the daily routine of the patient or affects her health. The vomiting may be so extreme that she is unable to retain any food or fluid and becomes wasted and dehydrated in consequence. Severe or persistent vomiting which imperils the patient's life is very rare.

Ætiology. The exact ætiology of this type of vomiting is unknown. Its persistence in some cases may be due to psychological factors. That its primary onset is not entirely due to such factors is indicated by the observation that pregnant women frequently complain of nausea and vomiting before they are aware of the pregnancy, e.g. before a period is missed or when conception has occurred during a period of amenorrhœa associated with lactation. Moreover, it would be clearly unjustifiable to suggest that the large number of pregnant women who suffer from transitory sickness are all neurotic.

It has been contended that the physiological degrees of nausea and vomiting of pregnancy are metabolic in origin, and that the pathological persistence and accentuation of the condition are essentially psychological. Many observations support this view. Among these may be mentioned the fact that many of these patients show resentment at or rejection of the pregnancy, and that the vomiting ceases as soon as the patient is removed from her home surroundings. This view is further supported by the large number of different drugs which have had their vogue and adherents. The cure of a symptom by suggestion, however, is not proof of its psychological origin. Incidentally, an unwelcome pregnancy raises an obstacle to treatment as the patient is sometimes essentially hostile to psycho-therapeutic measures.

There is no evidence for a specific toxin which causes hyperemesis. Nor is there any biochemical abnormality at the onset of the condition. Whatever biochemical changes are found can, in every case, be accounted for by the vomiting and the consequent starvation and dehydration. Toxic effects upon the liver and brain in the most severe and fortunately very rare cases are considered more likely to be due to deprivation of essential biochemical factors than to poisoning. The comparatively high incidence of hyperemesis in cases of hydatidiform mole and twins has led to the theory of an endocrine excess as the cause of vomiting. In these

conditions an excess of chorionic gonadotrophin is produced and the time in pregnancy at which hyperemesis occurs coincides with the time of greatest secretion of this hormone.

Effects of hyperemesis gravidarum. These are essentially dehydration and starvation. In the milder cases, vomiting may be frequent and persistent. Although the patient is incapacitated and miserable as a result, her health remains unaffected.

In more severe cases, water depletion leads to loss of weight, a dry inelastic skin and dry tongue, sunken eyes, fall in blood pressure, rise in pulse-rate, oliguria and constipation. Starvation further reduces the weight of these patients and accounts for their prostration and general muscular weakness. Carbohydrate depletion occurs relatively soon as the result of vomiting in the pregnant woman. This may be due to the added demands of the fœtus. For energy she has to call upon her fat reserves. But the normal rate of metabolism of fat in the liver requires a certain amount of available carbohydrate. In the absence of carbohydrate fats are broken down at so great a rate that the breakdown products, aceto-acetic acid, β-hydroxybutyric acid and acetone, accumulate in the blood. These fat metabolites are called ketone bodies. Acetone appears in the breath and can be detected in these cases by its characteristic smell. Acetonuria is diagnosed by Rothera's test on the urine or by a positive reaction with ferric chloride. The test may conveniently be carried out with one of the proprietary indicators (e.g. Ketostix).

Excretion of ketone bodies in the urine helps to prevent a change in the pH of the blood and inevitably means the passage through the glomeruli of a highly acid renal filtrate. In the renal tubules ammonia is secreted and neutralizes the acid in the urine by the formation of ammonium salts. The percentage of nitrogen in the urine excreted as ammonia is called the ammonia coefficient. Normally it is about 5, and it is said to be a measure of the degree of ketosis. But the increase in the ammonia coefficient in hyperemesis is not entirely due to the passage of acids through the kidneys because the total nitrogen excreted in the urine falls in starvation and thus the ammonia percentage tends to rise.

In the most extreme cases the continual retching and vomiting, rising pulse-rate and falling blood pressure, weakness, exhaustion and emaciation lead to severe deterioration in the patient's condition. Death may take place from heart failure or may be precipitated by surgical intervention and shock. Fatal complications may develop in the nervous system and jaundice may herald the onset of liver failure. Lesions occurring in the central nervous system and the liver are in all probability due to starvation. Nervous lesions include peripheral neuritis and a condition known as Wernicke's

encephalopathy (in which nystagmus, diplopia, cranial nerve palsies and a peculiar mental change are associated with hæmorrhages in the hypothalamus and brain stem). These are all thought to be due to deprivation of vitamin B complex. The syndrome is identical to the one found in chronic alcoholism. Pronounced starvation changes may be found in the liver, but it is not clear why they should ever of themselves prove fatal.

Pathology. Few patients suffering from the milder forms of vomiting die and therefore the description of the pathological lesions is founded on the examination of severe cases.

Liver. Various microscopic lesions have been described but it has been shown that the liver lesions of pure hyperemesis gravidarum are simply fatty infiltration of liver cells without any necrosis. The fat globules are large and centrilobular in distribution. Such a lesion would not seem to contribute to the death of the patient and should be regarded as an incidental finding, due to vomiting and not causing it. Women who die from associated diseases later in pregnancy, such as pyelitis, show the same change in the liver if vomiting has been a prominent feature. Moreover, in about half the fatal cases of hyperemesis the histological appearances in the liver are normal. Patients who die with massive necrosis of the liver are nearly always cases of severe virus infection, or of toxic effect from some drug, conditioned, perhaps, by protein deficiency, in particular deficiency of the amino-acids cystine and methionine. In these instances pregnancy is co-incidental and the vomiting is the result rather than the cause of the disease. Centrilobular zonal necrosis of the liver may also occur when chloroform has been given to a patient with hyperemesis.

Kidneys. There are usually no significant changes.

Heart. A constant finding is a small atrophic heart. The degree of atrophy is in accordance with the duration of vomiting. It would partly explain the fall in blood pressure and the rise in pulse-rate. The reason for this atrophy is not clear.

Brain. In a few cases in which they have been specially looked for the lesions of Wernicke's encephalopathy have been found. These consist of hæmorrhages in parts of the hypothalamus, in the corpora mammillaria, the corpora quadrigemina, the walls of the third ventricle, the floor of the fourth ventricle and the olivary nuclei. These lesions are associated with specific phsyical signs in the central nervous system, such as nystagmus, cranial nerve palsies and mental apathy.

Symptoms and signs. In hyperemesis gravidarum the symptoms begin as in the ordinary early morning vomiting of pregnancy. The vomiting, however, either persists beyond the 14th week, the date at which the

ordinary vomiting usually stops, or becomes more severe. The patient is sick after every meal and also between meals, she is unable to absorb nourishment and her rest may be disturbed on account of the continual retching and the vomiting at night.

If severe vomiting continues for several days the patient becomes dehydrated, wasted and exhausted. Her pulse-rate rises to about 100 per minute, and her systolic blood pressure falls to 100 mm. She loses weight and her dry skin, sunken eyes and dry tongue show that she is becoming dehydrated. She becomes constipated. There is acetone in the breath. The urine, small in amount and concentrated, contains ketone bodies. In a very grave case emaciation increases, material like coffee grounds is vomited, the pulse-rate is likely to be 120 or more per minute, the temperature becomes raised and the systolic blood pressure may fall to 80 or 90 mm. Ketone bodies are present in the urine; albuminuria may appear; the ammonia coefficient may rise to 20 and although the blood-urea is increased the total daily excretion of nitrogen falls. Unless pregnancy is terminated in such a case central nervous signs may develop, indicating in some cases Wernicke's encephalopathy. Involvement of the central nervous system is shown by the development of nystagmus, ocular or other cranial nerve palsies, such as paralysis of the soft palate producing nasal regurgitation on swallowing, apathy and drowsiness or, occasionally, excessive loquacity, diplopia or even blindness with optic neuritis. Mental changes of the Korsakoff type occur, in which the patient is confused and deluded with a loss of memory for recent events. Peripheral neuritis causes tenderness of the muscles of the legs and subsequently foot-drop and wrist-drop. Nervous complications may occur some days after vomiting has ceased.

Jaundice may develop in cases with extreme fatty infiltration of the liver (without necrosis). This is known as *icterus gravis gravidarum* (see p. 285). In a few cases acute hepatic necrosis, with jaundice, pyrexia, confusion and coma, has been attributed to hyperemesis gravidarum, but such an outcome is very rare today. Hepatic necrosis which was formerly observed may have been due to chloroform anæsthesia used for termination of pregnancy. It must be again stressed that severe and complicated cases of hyperemesis are fortunately very rare. Most cases respond to treatment.

Diagnosis. The first essential in diagnosis is to make sure that the vomiting is not due to any of the associated causes already mentioned by careful investigation into the history of the vomiting and a general examination of the patient. It is of importance to consider the possibility of poisoning by abortifacients. Abdominal scars may indicate the possibility of intestinal obstruction.

Prognosis. The prognosis is satisfactory if the patient is properly managed and it is rarely necessary to empty the uterus. Although artificial termination of pregnancy may very rarely prove necessary to save the patient's life, it may imply that the case has been mismanaged in its earlier stages, and therefore represent a confession of failure. No case of persistent vomiting should be regarded as trivial since neglect or unintelligent treatment may determine a rapid progress of the condition and eventually lead to death. A recurrence of the vomiting is liable to take place in succeeding pregnancies.

Treatment. The ordinary form of vomiting which occurs during the early months of pregnancy can be treated, usually with success, by means of simple remedies. The patient should be told to take a dry biscuit or piece of toast as soon as she wakes, so that she is not allowed to feel any faintness which might ensue were she to wait for her breakfast hour. She should be advised to take her breakfast in bed, to remain in the recumbent position for about half an hour afterwards, and to get up slowly. Even if she is sick, it is better for her to take food rather than to starve herself. She should be encouraged by the knowledge that many pregnant women complain of vomiting and nausea, but that the symptoms are only of a temporary character.

She is advised, if the vomiting tends to recur during the day, to take frequent small meals of a carbohydrate nature; not to mix solid and fluid; and to avoid large meals and fats. Drugs which may be of use are meclozine (Ancolan) 25 mg., promethazine theoclate (Avomine) 25 mg., promethazine (Phenergan) 25 mg., dimenhydriate (Dramamine) 50 mg., and mepyramine (Anthisan) 50 mg., one of which may be given two or three times daily. Some patients are improved by the administration of an alkaline mixture containing magnesium trisilicate 2 G. (30 gr.). Vitamin B has been tried without success. It is important that this form of vomiting should not be allowed to drift on unchecked, otherwise, owing to the consequent starvation, loss of fluid and ketosis, the patient's condition may become serious: once she has reached the stage at which there is almost continuous vomiting, rise of pulse-rate, loss of sleep, wasting and exhaustion, the treatment becomes correspondingly more difficult, and more energetic measures are required.

An essential part of the treatment, if the vomiting is severe, is to remove the patient from her home. In most cases it is very striking how rapidly the vomiting ceases when the patient is removed to a hospital or nursing home. She cannot be expected to recover so long as she is surrounded by over-anxious relatives, or a fussy nurse who is continually offering her a basin, and keeps the bedclothes covered with waterproof sheeting. These are direct incentives to vomit; it is obvious to her that she is expected to

do so, and the suggestive influence of these surroundings tends to a continuance of the vomiting. The patient must be made to understand that the condition will soon pass, and she will be cured with certainty. It is better not to give her a fluid diet but to put her on to solids from the commencement of the treatment. The amount should be small in quantity and given at frequent intervals. As a general rule these methods of treatment give immediate and striking results, for the patient, having found she can retain her food, is so impressed and encouraged that very little further persuasion is necessary and the further progress of the case is towards rapid and complete recovery. Drugs are not of great use in the treatment. Chlorpromazine (Largactil) 25–50 mg., or those listed in the previous paragraph may be tried.

In rare cases vomiting continues in spite of this management and the patient's condition deteriorates. An intravenous infusion of a solution of 4 per cent glucose with $\frac{1}{5}$ N saline is begun. Four to six pints of intravenous glucose-saline solution are given in 24 hours and a fluid balance chart is kept. In exceptionally severe and long-standing cases, 50 mg. vitamin B_1 (aneurin hydrochloride) or the equivalent dose of vitamin B complex, and 10 units of insulin may be added to each pint of solution. The insulin is given to stimulate the metabolism of carbohydrate in the liver.

Termination of pregnancy. This measure is very rarely required and should only be considered if deterioration continues after adequate intravenous replacement therapy. Many of the signs that were formerly observed in advanced cases, such as alterations in pulse-rate, blood pressure and oliguria were only signs of inadequate replacement of fluid and electrolytes.

Termination, usually by hysterotomy, might be required in a case with signs of involvement of the central nervous system or of hepatic damage.

DISPLACEMENTS OF THE PREGNANT UTERUS

Retroversion

IT was formerly thought that pregnancy occurs less readily in the retroverted uterus, but this is untrue unless the retroversion is associated with some uterine abnormality, or is due to salpingitis or endometriosis. Pregnancy occurs in the retroverted uterus of both the congenital and acquired varieties, and the pregnancy usually goes to term without complication. The fundus uteri rises spontaneously from the pelvic cavity into the abdomen as pregnancy proceeds.

Pregnancy in a backwardly displaced uterus continues, as a rule, up to the end of the 12th week without giving rise to any symptoms, so that it remains undiscovered unless a bimanual examination has been made.

Between the 12th and 16th weeks, in the great majority of cases, the displacement is gradually corrected by the growth of the uterus and by the fundus rising out of the pelvic cavity. In a small minority of cases, in rare instances in association with a flat pelvis with a projecting promontory, this correction does not occur, and the developing uterus gradually fills the pelvic cavity completely and there becomes impacted. Retention of urine and abortion may occur owing to the inability of the uterus to rise into the abdomen.

This condition is known as incarceration, and is of importance because of the grave results which may be produced in the urinary system if it is not relieved. At first pain occurs in the lower abdomen and back; as the intrapelvic pressure increases, the bladder is pushed up into the abdomen and the urethra elongated. With elongation of the urethra retention of urine usually results. This retention has been ascribed to pressure on the urethra, but this is not the case, as a soft catheter can easily be passed. It may be due to some interference with the neuro-muscular mechanism of micturition and the elongation and curving of the urethra (Fig. 76). If a tube is stretched its lumen is reduced.

When the overdistension has become sufficiently great, incontinence of urine will follow, the bladder voiding a little urine at frequent intervals, but never being able to empty itself completely. This condition is generally known as retention of urine with overflow, or the incontinence of retention.

If the bladder is not relieved, cystitis develops, the walls of the bladder become œdematous and thick, and in grossly neglected cases gangrene of the mucous membrane may ensue, and this membrane may be passed *per urethram.*
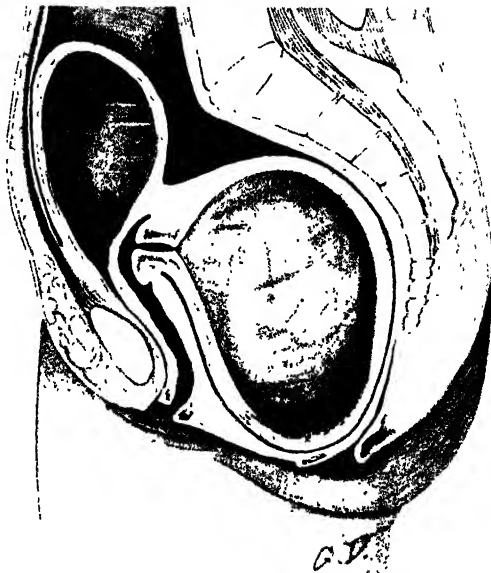
FIG. 76.   Incarcerated retroverted gravid uterus, showing retention of urine.
The body of the uterus is incarcerated below the promontory of the sacrum. The cervix is displaced upwards, lengthening the urethra.

DIAGNOSIS

Any disturbance of the bladder function between the 12th and 16th weeks of pregnancy should direct attention to the possibility of a retro-displaced uterus. Obstruction to the passage of urine may be sudden and absolute, or there may be a complaint of frequent micturition with slight incontinence. Pain may be entirely absent.

Abdominally, the distended bladder will be detected as a tense fluctuating tumour, which disappears when a catheter is passed and the bladder emptied. It should be remembered that the degree of distension may be great; the bladder may contain as much as 5 or more pints (2·5 litres) of urine which may have to be drawn off.

On attempting to introduce the finger into the vagina unusual difficulty is experienced, since the posterior vaginal wall is pushed forward by a smooth elastic swelling which occupies the hollow of the sacrum. This

is made out to be the uterus, and on seeking the cervix it is found to be high up behind the symphysis pubis, or in some patients cannot be reached by the examining finger.

The condition most likely to be confused with a retroverted gravid uterus is a pelvic hæmatocele. The history may give valuable assistance, but the diagnosis can be cleared up only by making out that in the case of a pelvic hæmatocele the slightly enlarged uterus lies in front of a soft mass with the cervix pointing downwards. In the case of a retroverted gravid uterus, the uterus itself is enlarged and retroverted, so that the cervix is high up and above the symphysis pubis; if the cervix can be reached it will be found to be pointing forwards. Another uncommon condition which gives rise to similar symptoms is a fibroid in the posterior wall of the uterus, and if the fibroid is associated with pregnancy the differential diagnosis will often be attended with very real difficulty. A single interstitial fibroid causes a symmetrical enlargement of the uterus, and during pregnancy the fibroid frequently becomes soft. As the treatment early in pregnancy is expectant, like that of a retroverted gravid uterus, the differential diagnosis is not of great practical importance.

TREATMENT

Treatment before retention has occurred. If a patient is found to have an 8 or 10 weeks' pregnancy in a retroverted uterus there is no need to interfere as the uterus will probably replace itself if left alone. The patient should be kept under observation. The growth of the uterus usually corrects the displacement between the 3rd and 4th months of pregnancy, and once the uterus is 16 weeks pregnant it is too big to become retroverted again. Patients treated in this way are less likely to abort than those in whom the early pregnant uterus is replaced manually.

Treatment when retention has occurred. The organ that requires treatment is the bladder, not the uterus; the displacement of the uterus is only of importance because it upsets the function of the bladder. If retention is not relieved there is danger of cystitis. A catheter is passed with sterile precautions and the bladder is drained continuously with the patient in the semi-prone position. In cases of acute retention there is no risk in emptying the bladder rapidly. Spontaneous rectification of the uterus nearly always follows within 24 hours and can be confirmed by bimanual examination. The catheter is then discontinued and the patient allowed up and about.

In the extremely rare cases in which spontaneous rectification of the uterus does not follow catheterization the position of the uterus may need to be corrected by manipulation under anæsthesia.

Abnormal anteversion of the pregnant uterus

In multiparæ during the later months, owing to atony of the abdominal muscles, or in primigravidæ owing to pelvic contraction or spinal deformity, the fundus uteri may fall right forward, and the abdomen become unusually prominent. This condition is known as pendulous belly and may be responsible for the production of malpresentations.

The treatment in pregnancy is to fit a suitable belt or corset; during labour a firm abdominal binder should be adjusted, and labour should

FIG. 77.   Anteversion of pregnant uterus, 'Pendulous belly'.

be conducted with the patient on her back until the presenting part has entered the pelvic cavity. This will correct the faulty axis of the uterus and enable the contractions to act in the right direction. Because of the loss of the auxiliary abdominal muscles in the second stage delivery by the forceps may be required.

Sacculation of the pregnant uterus

The very rare condition of sacculation of the uterus may occur from the disproportionate expansion of either the anterior or the posterior uterine walls.

If a retroverted uterus becomes incarcerated sacculation of the anterior wall may occur and delivery will be obstructed. Posterior sacculation has

followed the obsolete operation of ventrofixation, in which the anterior surface of the uterus is attached to the anterior abdominal wall.

Prolapse

Pregnancy in a partially prolapsed uterus is not at all unusual. In such cases, as the pregnancy advances the uterus often, but not invariably, rises up in the pelvis until it has passed the inlet, and then prolapse is no longer possible. The minor degrees of prolapse only require treatment until the uterus has risen above the inlet, and insertion of a suitable ring pessary is usually sufficient. Vaginal wall prolapse commonly becomes more marked during pregnancy and may be treated by a ring pessary.

Pregnancy in a completely prolapsed uterus is very rare. As a rule the cervix becomes retracted when labour begins, though on rare occasions it remains protruding through the vulva, becomes swollen, and so gives rise to obstruction. Sepsis should be treated by disinfection with a non-irritating antiseptic, but the most important point is that the patient should be kept in bed for some days before labour, with the cervix within the vagina to allow the œdematous swelling to subside. The increased danger of puerperal sepsis in these cases is an additional reason for keeping such patients in bed in order to keep the exposed parts free from fresh contamination after they have been cleansed with an antiseptic, and the foot of the bed should be raised.

It is usual to delay operation for prolapse until the patient has completed her family. If however, she becomes pregnant again after a repair has been carried out some obstetricians would always advise delivery by Cæsarean section, but others believe that normal labour should be allowed to take place with an episiotomy and low forceps delivery to protect the reconstituted supports of the uterus and vagina. If the cervix has been amputated it usually dilates more quickly than usual but occasionally dystocia develops and either the cervix tears or fails to dilate. In such a case Cæsarean section is carried out at once. It would be generally agreed that in a case in which there was stress incontinence before the operation, and in which this complaint has been successfully cured, Cæsarean section should be advised.

All these cases should be delivered in hospital.

Hernia and pregnancy

As a general rule herniæ are not made worse by, and do not affect the course of, pregnancy. Symptoms from inguinal and femoral herniæ are usually improved, as the growing uterus pushes the bowel away from the orifices and eventually blocks access to them. Rarely these types of herniæ may first appear during pregnancy. Fluctuant swellings which appear in the

groin during pregnancy are usually found to be varicoceles. Should thrombosis occur in them they may be confused with strangulated herniæ.

In the case of umbilical hernia, if intestine is adherent to the sac, it may become dragged upon by the growing uterus and intestinal obstruction may occasionally follow.

Diaphragmatic hernia is a rare but occasional complication of childbearing in women in whom there exists a congenital deficiency in the diaphragm. Through this the upwardly displaced bowel and stomach may be forced into the thorax. Much more common is the condition known as hiatus hernia. Such patients complain of vomiting throughout the pregnancy, perhaps increasing as term approaches. They also have severe heartburn and may find relief by sleeping propped up with pillows, because lying down, particularly after a meal, makes the symptoms worse. All symptoms of hiatus hernia usually disappear after delivery.

Abnormalities of the genital tract

There are many kinds of uterine abnormality which do not necessarily prevent pregnancy occurring.

A woman with a double uterus and cervix may become pregnant in one or both horns and labour is often normal. If pregnancy occurs in only one uterus it is possible for the other one, which undergoes both myometrial and decidual hypertrophy, to obstruct the entrance of the fœtal presenting part into the brim of the pelvis and Cæsarean section may be necessary. The smaller uterus is sometimes mistaken for a fibroid.

A bicornute or arcuate uterus may cause a malpresentation at term, sometimes a shoulder presentation. Such developmental abnormalities, including septate uterus, may also cause repeated abortion.

A septate vagina may be present with or without a double uterus and cervix. Often there is no obstruction to delivery although the septum may have to be excised.

The more gross manifestations of uterine abnormality are often accompanied by hypoplasia and infertility so that complications of pregnancy do not occur.

ABORTION AND INTRA-UTERINE FŒTAL DEATH

THE earliest date at which the fœtus is considered viable is the 28th week; the expulsion of the fœtus before the 28th week is known as abortion or miscarriage, whereas after that date it is spoken of as premature labour. The terms 'abortion' and 'miscarriage' are synonymous, although the laity is apt to associate the former with illegal procedures. There is no sharp line of distinction between a late abortion and an early premature labour— the division is merely one of convenience. Similarly, it will be found that many cases of abortion pass gradually into the cases which are discussed under the title of antepartum hæmorrhage. In both, bleeding before delivery is a cardinal symptom, the causation is often similar and the surgical principles guiding the treatment are identical. In Britain, delivery of the fœtus before the 28th week of intra-uterine life is not notifiable unless the fœtus is born alive but all deliveries after this date must be notified.'

Frequency. It is impossible to give an accurate figure of the frequency of abortion because many patients who are aborting do not seek medical advice. Again, many of the earlier cases are not definitely diagnosed, but are regarded by the patient as a delayed menstrual period or a flooding, and a doctor is not consulted. Also, frequently, a patient may conceal the fact that she has had an abortion. It has, however, been computed that 10 to 15 per cent. of pregnancies end in abortion. The proportion of abortions to full-time labours is higher in large cities than in rural districts. It is difficult to assess the frequency with which abortion is induced criminally, but the figure is high, particularly in the large cities, and it is this type of abortion which has the highest morbidity and mortality.

Period of pregnancy. The most common time for abortion to occur is from 8 to 13 weeks; doubtless many early cases are unrecognized, especially those occurring after only a short period of amenorrhœa.

CAUSES OF ABORTION

In at least 50 per cent of cases a definite cause cannot be determined; even when one is recognizable, its method of action is frequently obscure, so that any attempt at classification of the causes of abortion must be, to a certain extent, theoretical and arbitrary.

1. Maternal

(a) *General conditions*
Endocrine imbalance, such as progesterone deficiency, and possibly diabetes and hypothyroidism.
Chronic nephritis and essential hypertension.
Any acute febrile illness.
Syphilis.
Lead poisoning, or severe toxic effect of other drugs.

(b) *Local conditions*
Retroversion of the uterus (if the uterus becomes incarcerated), uterine fibroids, and incompetence of the cervix.
Congenital abnormalities of the uterus.

(c) *Reflex stimulation of the uterus* by emotional disturbances.

2. Ovular

Abnormality of the Germ Cells leading to gross malformation of the embryo including:

(a) Early atrophy of the embryonic cell mass (blighted ovum).

(b) Hydatidiform mole.

3. Traumatic

(a) *Criminal abortion*
Introduction of foreign bodies or irritating chemicals into the uterine cavity.

(b) *Irritation of or damage to the uterus and adnexa* during operations such as myomectomy or oöphorectomy, or during the replacement of a retroverted gravid uterus.

(c) *Coitus during the first 3 months of pregnancy.*

The commonest cause of spontaneous abortion is an abnormality of development of the fœtus or trophoblast which is severe enough to cause death and for which either of the parents may have been responsible. This condition is in most cases a non-recurring factor, and the patient has an 80 to 90 per cent chance of going to term on the next occasion. For this reason it is safe to reassure the patient who has miscarried for the first time that her next pregnancy will probably be uneventful. Patients may be reassured that such abnormalities are most unlikely to recur in subsequent pregnancies.

Probably the second commonest cause of miscarriage is an abnormality of hormonal balance or of development of the uterus.

The successful continuation of pregnancy depends upon the adequate secretion of progesterone by the corpus luteum in the early weeks and its continued secretion by the placenta from the time of its full formation.

The action of progesterone is concerned mainly in the proper embedding of the growing ovum in a fully formed decidua; but it is also said to be concerned in a desensitizing effect upon the uterine muscle to neutralize the latter's reaction to the oxytocic factor of the posterior pituitary. This desensitizing action may play a part in the later months of pregnancy in preventing the onset of premature labour, it may also play a part in the early months in the prevention of abortion. When adequate laboratory facilities are available the degree of progesterone activity may be assessed by estimating the amount of its excretory product, pregnandiol, in the urine. The amount of pregnandiol excreted rises until about the 34th week of a normal pregnancy; it then decreases and finally disappears a few days after delivery. In cases of threatened abortion a 24 hour specimen of urine is investigated for pregnandiol content and if the amount decreases in successive specimens it can be assumed that the attachment of the ovum to the decidua is precarious. Obviously such a finding may denote that it is too late to do anything to prevent the threatened abortion at this stage becoming inevitable, and the low pregnandiol secretion may even denote that the ovum is already dead *in utero*. This test, which is time-consuming and not easy to carry out, is not really of much value when undertaken in cases in which there is already a threat to abort. If the test is to be used rationally it might be done repeatedly in cases of habitual abortion, before the bleeding begins. If the readings were low in these circumstances progesterone given in large doses might prevent the onset of a miscarriage.

It is easier to obtain evidence of progesterone deficiency by examination of vaginal smears. Repeated examinations are required. In normal pregnancy the smear shows clusters of navicular cells. These are 'boat-shaped' cells derived from the intermediate cell layers, and such cells replace the flat squames seen in the smear at other times.

Thyroid deficiency may be a cause of miscarriage, but thyroid extract should only be given where there is clear evidence of deficiency.

Any general disease may cause abortion if it is sufficiently severe and this applies specially to acute illness in which the temperature is high and the toxæmia severe. Malnutrition and severe hypovitaminosis are other causes, but they are uncommon in the British Isles where the intake of vitamins is generally adequate. Although gross deficiency of vitamin E is a proven cause of abortion in experimental animals its administration to women who tend to abort is of no value because of the quantity of vitamin present in the average diet.

The abortion rate is increased above the average in the diabetic mother whose disease is not adequately controlled. The association of chronic forms of nephritis with pregnancy is not very common yet there is always a risk of abortion occurring, although the fœtus is in greater danger later

on in the pregnancy when placental changes may cause anoxia and fœtal death.

Syphilis does not cause early miscarriage and is an uncommon cause of late miscarriage; the disease is more likely to cause death *in utero* after the 28th week of intra-uterine life.

If lead is absorbed by a pregnant woman it may effect the ovum and result in abortion. For this reason pills containing lead are sometimes administered in a criminal attempt to produce abortion.

The woman who becomes pregnant when suffering from essential hypertension may miscarry, although she is more likely to produce a small premature baby with a tiny placenta, and there is a risk of fœtal death *in utero* from anoxia. A superimposed toxæmia of pregnancy is a common complication and increases the dangers to the fœtus very greatly.

There is no doubt that an acute emotional shock may cause abortion.

Pelvic abnormalities

A fibromyoma of the uterus may cause a miscarriage if it is submucous in situation. However, many women with small uterine fibroids which are not submucous succeed both in becoming pregnant and in having a normal pregnancy and labour. Retroversion of the uterus is often found in early pregnancy, but the malposition itself is not a cause of abortion unless the uterus becomes incarcerated.

Uterine malformations are associated with an increased incidence of abortion, but in many such cases the course of pregnancy is uneventful.

When an ovarian cyst is found in association with early pregnancy the cyst should be removed after the 16th week. The corpus luteum may be situated in the ovary which contains the cyst and removal before this date will greatly increase the risk of abortion as a result of the operation.

Extensive lacerations of the cervix which reach as far as the internal os may result in abortion in the second trimester. At this stage of pregnancy the membranes begin to impinge upon the internal os, for the fœtus now fills the whole uterine cavity. If the membranes are not properly supported they may rupture and abortion will result.

Even without extensive laceration of the cervix, the internal os may be functionally inadequate. Rarely this is of congenital origin but more commonly it is due to a previous vigorous dilatation of the cervix for dysmenorrhœa, to surgical evacuation of the uterus in incomplete abortion or even to precipitate labour on a previous occasion.

Criminally-induced abortion

All attempts to procure abortion by whatever method and however early in the pregnancy are illegal, even if unsuccessful. Advice given to the

woman as to whom to consult for the procuring of an abortion is illegal and the informer risks a charge of aiding and abetting.

The methods adopted may be classified into three main groups—taking abortifacient drugs, indulgence in violent physical exercise, and the introduction of fluids, foreign bodies or instruments into the uterus. The common method of injecting soapy water by means of a syringe into the cervical canal occasionally leads to death from air embolism. The drugs used include quinine, ergot, pennyroyal and strong purges, usually taken in an attempt to irritate the uterus and cause it to expel the ovum; or lead salts which it is hoped will kill the ovum.

The passage of slippery elm bark, crochet-needles, douche-nozzles by the patient, or catheters, sounds or blunt syringe-nozzles by the abortionist may cause serious lacerations of the vagina, cervix and uterus. The instrument is frequently not sterile and so the interior of the uterus is often infected; if a laceration is caused, it is also infected. The risks are increased if fluid is forced into the uterus or peritoneal cavity. The presence of abrasions or lacerations in the genital tract with or without the early onset of signs of infection strongly suggests criminal interference. Many women indulge in strenuous physical exercise with or without hot or cold baths in the hope of inducing a hæmorrhage from the uterus. But it is an extremely uncertain method, as some women can go through serious accidents or undergo abdominal operations without miscarriage, whereas others may abort after the slightest strain. Induced abortions often occur between the 8th and 12th weeks of pregnancy, because it is not until the second period is missed that the patient decides that she must be pregnant and then takes steps to have the pregnancy terminated.

The maternal mortality following criminal abortion is about eight times greater than that associated with spontaneous abortion, which is proof enough of the very great danger attendant upon criminal interference in these cases. Since the advent of sulphonamides and the antibiotics the total number of deaths from abortion in the British Isles have been reduced from 233 in 1945 to 63 in 1958.

The direct causes of death associated with abortion are as follows:

(a) *Sepsis.* The pattern has changed in recent years. The hæmolytic streptococcus was lethal in the earlier part of the century but now the *Staphylococcus aureus,* so often resistant to penicillin, is the most common causative organism and this is followed in order of frequency by coliforms and the anærobic organisms. Infection with *Clostridium welchii* is still potentially lethal and demands urgent treatment.

Criminal interference by means of an instrument frequently introduces a pathological organism from an extraneous source directly into the choriodecidual space, and acute inflammation of the decidua and septicæmia may

'
follow. At a later date salpingitis and spreading peritonitis may develop; or
the latter may occur quickly and acutely due to perforation of the uterus or
the recto-vaginal pouch by an instrument. An instrument may be passed
obliquely into the uterus and thus perforate the muscle wall and enter the
broad ligament where pelvic cellulitis or a pelvic abscess may occur.

(*b*) *Hæmorrhage.* A combination of sepsis and severe hæmorrhage is the
most dangerous of all, and replacement of blood loss is absolutely essential
in the severely anæmic patient. The mobile emergency unit (flying squad)
may have to be called upon to treat the patient in her own home in cases in
which collapse has occurred as a result of an incomplete abortion with
torrential bleeding. The transfer of such a case by ambulance before the
anæmia and shock have been treated may prove fatal.

(*c*) *Shock.* A combination of tissue damage and hæmorrhage in criminal
abortion is the commonest cause of shock in these cases. Occasionally a
patient collapses and dies from profound shock when an instrument is
passed through the internal os without an anæsthetic in a frightened woman
who realizes she is taking a risk. The injection of soapy water into the uterus
may also have the same effect.

(*d*) *Oliguria or anuria.* This may occur in cases with severe shock,
particularly in association with a septic abortion. It is usually due to lower
nephron necrosis, and with expert care in a metabolic unit, sometimes with
the use of the artificial kidney, this complication should not prove fatal
as the renal lesion is usually reversible; although with the added hazards
of sepsis and hæmorrhage deaths still occur.

CLINICAL VARIETIES

It is customary to make use of certain terms to describe the clinical
varieties of abortion.

Classification

1. Threatened abortion.
2. Inevitable abortion.
3. Complete abortion.
4. Incomplete abortion.

5. Septic abortion.
6. Missed abortion.
7. Habitual abortion.

(1) *Threatened abortion.* When the process of abortion begins but is
arrested before is has reached a phase from which recovery is impossible,
the case is described as one of threatened abortion. There is uterine
bleeding and occasionally some pain in the lower abdomen, although once
painful contractions occur it is likely that the abortion will be inevitable.
In threatened abortion there is no dilatation of the cervix.

The decision whether abortion is only threatened or is inevitable is, from the point of view of treatment, of the first importance. It is, however, not always easy to draw a definite border line. Abortion does not necessarily follow even after repeated attacks of quite sharp bleeding, and it is not very unusual to meet cases in which slight hæmorrhage has continued for some time, and yet a healthy child has been born at term. These cases should, however, always be regarded as serious, since at any time profuse bleeding may take place and the abortion will then become inevitable. Dilatation of the internal os should be regarded as an indication that the abortion is becoming inevitable. An abortion may therefore be regarded as threatened if (a) the pain is slight; (b) the bleeding is slight; (c) the cervix is not dilating.

The type of bleeding in threatened abortion is significant. The hæmorrhage comes from either the potential cavity in the decidua lining the uterus, which is present until the ovum fills the whole cavity at the 12th week, or more often from the attachment of the fœtal trophoblast to the decidua basalis or the decidua capsularis. In either case the hæmorrhage is at first bright in colour. If it continues to be bright red and increases in amount the prognosis is correspondingly less good. A single bright loss followed by the escape of old brown blood merely means that an initial hæmorrhage has occurred but none since. It is not uncommon in threatened abortion after the 12th week for such a dark brown blood-loss to go on for 1 to 2 weeks. This can usually be taken to mean that the fœtus is growing satisfactorily.

The amount of blood-loss which can occur without the abortion becoming inevitable is surprising. All cases should be treated as threatened unless there is very good evidence for saying they are inevitable.

It is wise to pass a speculum with great gentleness to make sure that the hæmorrhage is not caused by a mucous polypus or even a carcinoma of the cervix. It is well to remember that sometimes potassium permanganate crystals are sold as an abortifacient drug. The tablets are placed in the vagina and ulceration with bleeding follows. The fœtus is not at risk as the decidual cavity and cervical canal are not involved, but the patient attends hospital or calls in a doctor because the bleeding, which can be severe, suggests to her that an inevitable miscarriage is occurring.

(2) *Inevitable abortion.* A threatened abortion becomes inevitable when the bleeding increases greatly and uterine contractions become rhythmical and strong. The cervix then begins to dilate and products of conception may sometimes be felt protruding through the external os. Before the 12th week it is quite common for the fœtus and trophoblast to be extruded intact when the abortion becomes complete. After the 12th week the membranes often rupture and the fœtus is passed, leaving the placenta behind, and all the complications of an incomplete abortion may arise.

(3) *Complete abortion.* A complete abortion is one in which all the products of conception have been expelled. On examination (*a*) pain is absent, and the bleeding small in amount; (*b*) the uterus is felt to be hard, inelastic and much smaller than the period of amenorrhœa would suggest; (*c*) if the material passed has been saved it will be found that the whole of the ovum is present; (*d*) the cervix may be only slightly patulous.

(4) *Incomplete abortion.* This means that part of the products of conception, usually the fœtus, has been passed but part, usually the placenta, is retained. The amount of bleeding varies, but may be heavy and bright at first and less in amount and darker later on. The uterus is enlarged, but not as much as would be expected for the duration of pregnancy, and the cervix is often dilated.

This condition may create one of the worst emergencies that any doctor has to deal with. It is possible for a woman to bleed so severely within the space of a few hours that the hæmoglobin level drops to 20 or 30 per cent and often accompanying this is a severe degree of shock.

(5) *Septic abortion.* The uterine cavity may become infected before an abortion begins. This is often the result of a criminal attempt to produce abortion with an instrument in the cervical canal. The patient has severe suprapubic pain and a raised temperature and pulse-rate. There may be little or no bleeding or uterine contractions and the cervical canal may remain closed. There is some rigidity of the abdominal wall spreading outwards and upwards from the pelvic brim. The uterus is exquisitely tender on bimanual examination. Unlike puerperal intra-uterine infections the organism in cases of septic abortion is often the staphylococcus and not the hæmolytic streptococcus. Other organisms may also be present, such as *E. coli* and *Streptococcus fæcalis*. An anærobic streptococcal infection is not uncommon and gas-forming organisms may also be found. If sepsis is present the abortion is always inevitable or incomplete. If the abortion is incomplete a piece of placenta may block the internal cervical os so that pus and blood collect above it, which often causes a high swinging temperature which drops dramatically when the uterus is evacuated.

In other severe cases of septic abortion septicæmia may be established before the patient calls in a doctor or attends hospital.

(6) *Missed abortion (Carneous mole).* A carneous mole is an ovum which has died in the early months of pregnancy. This is brought about by a slight progressive hæmorrhage which takes place into the decidua and choriodecidual space, and the blood is maternal in origin. If it is sufficiently sudden or extensive, abortion will take place, but if not, the effused blood eventually surrounds the ovum and separates it from its attachments.

The amnion, a resistant membrane, is usually found intact in the midst of the blood-clot. On rare occasions hæmorrhage takes place into its cavity.

There is often a marked disproportion between the state of the

development of the fœtus and the size of the amniotic cavity, and it has been suggested that this is due to an excessive amount of liquor amnii.

The amniotic cavity is surrounded by hillocks of blood clot, which have a fleshy appearance, hence the term 'carneous' which is applied to this condition. The wall on section shows at times a laminated appearance, and microscopic examination of a portion shows degenerated chorionic villi in the blood-clot.

Embryo
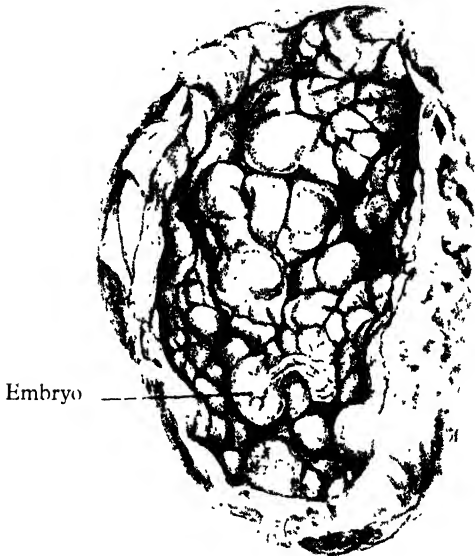
FIG. 78. Carneous mole.

The formation of a carneous mole is uncommon. In these cases the patient usually notices a little blood-stained discharge for a day or two about the 8th to the 12th week of pregnancy. After this the breasts cease to be tender and swollen, but the patient often pays no attention to this. It is necessary in all cases of pregnancy to examine the abdomen at the 16th or 20th week in case the uterus has ceased to increase in size after the 12th week. A carneous mole can remain in the uterus for many months.

In cases of missed abortion the breasts show no signs of recent activity and the uterus ceases to grow from the date of the small hæmorrhage. A pelvic examination reveals a firm uterus usually smaller than would be expected from the duration of amenorrhœa. The biological or immuno-logical pregnancy tests usually become negative about 10 days after the death of the ovum in these cases, but the tests sometimes remain weakly positive for some weeks, and give rise to confusion in diagnosis. It must

also be remembered that the tests may only be weakly positive after the third 'month in cases of normal pregnancy, because of the normal fall in the level of chorionic gonadotrophin at that time. When there is doubt about the diagnosis of a carneous mole the patient should be re-examined after three or four weeks, by which time a normal pregnancy will have increased in size whereas a carneous mole will remain unchanged or will have become smaller.

Patients who retain a dead fœtus are liable to defective blood coagulation due to hypofibrogenæmia. The reason for this is not known. It only occurs in a few of the cases and not for at least four weeks after fœtal death.

(7) *Habitual abortion.* By convention this refers to any case in which three consecutive spontaneous miscarriages have occurred. It can be shown statistically that a woman who miscarries for the first time has about an 90 per cent chance of going to term the next time she is pregnant. A woman who has had two consecutive miscarriages still has a 60 per cent chance in the next pregnancy, but after three consecutive abortions the chances of reaching full time on the fourth occasion drop to 20 per cent.

MORBID ANATOMY

In the first two months of pregnancy the attachment of the ovum to the decidua is so delicate that separation may follow uterine contractions produced by any cause; or the immediate cause of abortion in the early weeks may be hæmorrhage into the chorio-decidual space. The exact cause of that hæmorrhage is not known, but as a result of it the ovum becomes partly or totally separated from the decidua, and consequently acts as a foreign body and is expelled.

An examination of the structures cast off shows that in the majority of cases the decidua basalis remains in the uterus, and the ovum with a part or the whole of the decidua capsularis is expelled. Occasionally the entire ovum and the entire decidual lining are ejected, or only the decidua capsularis may be torn through, and the ovum, surrounded by chorionic villi, is discovered among the material expelled by the uterus (Fig. 79). The chorion also may be torn through and the fœtus expelled enclosed in its amnion and the liquor amnii; or the amnion also may be ruptured, and then the fœtus escapes uncovered.

·When the placenta is a definite structure, the fœtus is usually expelled first. It is followed by the placenta and membranes, but it is not unusual for the small placenta to be retained. Such retention may be associated with continued hæmorrhage. Septic infection of the retained products may ensue.

An abortion is in reality only a miniature labour, and in a typical case a

process is gone through which closely resembles that of labour at term. The uterus undergoes rhythmical contractions, the cervix dilates, and when the internal os is sufficiently open the ovum is expelled entire or in part by the uterine contractions. If the ovum is entirely expelled the pain

Fig. 79. Rupture of the decidua capsularis with escape of the ovum surrounded by its chorionic villi through the rent. Almost the whole decidua is left behind.

ceases and the hæmorrhage abates. For several days a blood-stained discharge continues to escape, but eventually ceases and the uterus involutes as after a normal labour.

DIFFERENTIAL DIAGNOSIS

An ectopic gestation may frequently be confused with an early abortion. This is a serious mistake, and a correct diagnosis is essential, since the former is a dangerous condition, and confusion may lead to disastrous results. Both are usually associated with a short period of amenorrhœa followed by uterine hæmorrhage which is irregular both as regards time and character. But the hæmorrhage is, typically, of quite a different nature in the two conditions. In abortion it is usually bright red and often accompanied by clots, and is much more profuse than in ectopic gestation. In the latter conditions the bleeding tends to be slight in amount and may be red or dark brown in colour; it is due to the casting off of the decidua. The occurrence of vaginal hæmorrhage in an ectopic gestation is usually preceded by severe abdominal pain. The pain commences low down in one

8*

or other iliac fossa but rapidly spreads across the lower abdomen. In abortion the pain is usually not nearly so severe and occurs after the onset of the bleeding; if present it is of the nature of miniature labour pains, but it is often slight.

The commonest fate of an ectopic pregnancy is the abortion of a tubal mole into the abdominal cavity and the formation of a pelvic hæmatocele. Consequently a definite mass appears in the pouch of Douglas posterolaterally to the uterus. This may be confused with a retroverted gravid uterus, but the position and direction of the cervix and the character of swelling will afford the evidence necessary to distinguish the conditions. If, however, the ectopic pregnancy should rupture, the onset of symptoms is very similar to that observed in other acute abdominal conditions. A pelvic swelling cannot at first be detected, but a fullness may be felt in the recto-vaginal pouch. If the amount of internal hæmorrhage is sufficiently great, movable percussion-dullness may be made out in the abdomen and the general signs of loss of blood, e.g. pallor, restlessness, air hunger and a rapid pulse, will be observed. It should, however, be urged that, unless it is unavoidable, it is very unwise to wait for the general signs of internal hæmorrhage before arriving at a diagnosis.

Other conditions which are associated with irregular uterine hæmorrhage, e.g. intra-uterine polypus, carcinoma, and metropathia hæmorrhagica are at times confused with abortion. A careful history and vaginal examination will, as a rule, make the diagnosis clear. It must not be forgotten that bleeding during pregnancy may be due to carcinoma of the cervix.

TREATMENT

General treatment. When considering the causes of abortion it was stated that in some cases a definite cause could not be assigned so that the prophylactic treatment must be based on general principles. In dealing with these unexplained cases, there is no doubt that the irritability of the uterus and its response to external stimuli vary considerably in apparently healthy individuals. Women who show this tendency to abort should not run any risks, coitus should be forbidden during early pregnancy and over-exertion avoided. The patient should be instructed to rest more and to avoid purgative medicines. If on the other hand, a cause can be detected, it should be treated before conception has taken place. In the majority of cases it is unnecessary and unwise to replace a retroverted gravid uterus or to insert a pessary during the early weeks of pregnancy. (See p. 219.)

When abortion seems to be impending, as evidenced by hæmorrhage and possibly pain, the first point to be settled is whether one is dealing with a threatened or an inevitable abortion. This can never be assessed with accuracy unless a vaginal examination is performed to discover whether

the cervix is dilated. This must be done with great gentleness to avoid stimulating contractions of the uterus.

A partially open cervix, severe bleeding, and palpation of part of the ovum protruding through the cervical canal are all indications of inevitable abortion. If the physical signs suggest that the abortion is still only threatened, the treatment described as suitable for this condition should be adopted. If, on the other hand, it is clear that nothing can save the pregnancy it should be treated as an inevitable abortion.

If there is an indefinite story of frequent attacks of bleeding of some severity with the passage of clots, and it is not clear what has been passed *per vaginam*, a diagnosis must be made from the general condition of the patient and the information obtained from a pelvic examination. If the size of the uterus corresponds with the duration of amenorrhœa and the loss of blood has not produced any marked symptoms, the case can be treated as a threatened abortion, and such patients may go to term in spite of several profuse bleedings. If, on the other hand, the os is dilated and it is clear that some portion of the ovum has escaped, or some portion of it is felt still protruding through the cervix, the uterus should be emptied without delay.

Again, if the uterus is still distinctly soft and larger than normal, though not large enough to correspond with the date of the pregnancy, and free hæmorrhage persists, even though the os be not widely dilated, it is safe to assume that some of the products of conception have been retained, and they should be removed forthwith. On rare occasions the uterus is much larger than the period of amenorrhœa would suggest and if hæmorrhage occurs and dilatation of the cervix begins, the presence of a vesicular mole should be suspected (p. 244).

As soon as there is convincing evidence that the fœtus is dead the uterus should be emptied, as delay may expose the patient to the risks of hæmorrhage or sepsis.

If the abortion occurs after the 16th week œstrogens should be given to suppress lactation.

Treatment of threatened abortion. Here the guiding principle is to arrest the process, and to that end the patient should be kept at rest in bed for 2 days after hæmorrhage has ceased. She should have a normal diet. There are few households now where a patient can be given a bed-pan on these occasions, and it will do her little harm if she goes to the lavatory when necessary. Otherwise she should stay strictly in bed. All pads and anything passed must be saved for examination, as this will assist diagnosis and avoid time-wasting conservative treatment once products of conception have been seen. If necessary the patient should be given paraffin or any mild aperient which suits her so that she does not have to strain at stool.

The administration of sedatives is important. An initial dose of morphine, 10 mg. (gr. $\frac{1}{6}$), is advisable if the patient is much upset, and then pheno-barbitone, 60 mg. (gr. 1) or less, three times a day, should be given for the next few days. Opinions differ so much on the vexed question of hormone deficiency in these cases that it is difficult to be dogmatic on this subject. The chances of a spontaneous recovery are high, and it is doubtful whether the administration of progesterone will be of any value.

When the patient has recovered she should be warned to take great care at the next two period times and to avoid coitus for the next 3 months.

Treatment of inevitable abortion. This may be summed up as the treatment of labour on a small scale. Generally, help is not necessary, the uterus expelling its contents unaided and involuting in the usual way. Any examination should be with aseptic technique bearing in mind the risk of infection. Care must be taken that anything passed is saved for examination. Treatment consists in complete rest in bed, which of itself lessens the amount of bleeding. Analgesics may be required, such as morphine 10 mg. (gr. $\frac{1}{6}$) or pethidine 100 mg. An intramuscular injection of ergometrine, 0·5 mg., should be given if necessary to control hæmorrhage.

The main indications for interference are profuse hæmorrhage and the manifest inability of the uterus to expel its contents.

If the hæmorrhage becomes excessive in quantity the uterus should be emptied; the method to be adopted will be indicated by the severity of the bleeding and the degree of dilatation of the cervix.

Treatment of incomplete abortion. Treatment should be directed to preventing septic infection, to controlling the bleeding and to obtaining a completely empty and involuted uterus. The chief risks associated with retained products are hæmorrhage and sepsis, and it is unwise to leave a piece of placenta in the uterus for any length of time in the hope that it may be expelled.

If the bleeding is severe there may be associated shock. If a patient is moved to hospital by ambulance before the shock is treated the latter may increase to a dangerous degree so that resuscitation becomes impossible. Such patients require immediate first aid, and a mobile emergency unit (flying squad) should be called upon to administer blood in the house before an ambulance takes the patient to hospital. The blood pressure should be taken and ergometrine, 0·5 mg., should be given at once by intramuscular injection. Even if the uterus is not empty the bleeding will often be reduced with the strong contraction induced by the ergometrine. Occasionally bleeding persists because a large piece of placenta is retained in the cervical canal and the removal of this under direct vision using

a sterile speculum and sponge forceps will be immediately effective in stopping hæmorrhage. The patient should be kept reasonably warm; the foot of the bed should be raised and morphine, 15 or 10 mg. (gr. $\frac{1}{4}$ or $\frac{1}{6}$), given. When the blood pressure has reached a more normal level the patient should be transferred to hospital; there she should be given an anæsthetic and the uterus emptied by the gloved finger or an ovum forceps (p. 569). Since the ovum has passed through the cervix it will usually be patulous and admit the finger without the use of dilators. Ergometrine (0·5 mg.) or Pitocin (5 units) is administered as soon as the uterus has been evacuated.

In some cases an incomplete abortion is not associated with severe bleeding, but the hæmorrhage continues intermittently for many weeks and is due to a placental polypus. The uterus remains bulky and the cervix slightly dilated. Surgical evacuation of the uterus is then essential, and the patient should be admitted to hospital.

Sometimes it is difficult to decide whether prolonged irregular bleeding after a miscarriage is due to a placental polypus or to a complete abortion followed by an anovular type of bleeding from the endometrium. This may occur before the normal ovarian cycle is re-established. In either event, if the hæmorrhage does not cease after a reasonable time, curettage is the best and most efficient form of treatment.

In all cases the most careful aseptic precautions must be used and the vulva kept covered by a sterile pad. Involution is frequently slow after the evacuation of an incomplete abortion and, therefore, the patient should be kept in bed for 5 days and should be given some preparation of ergot for 3 days.

Treatment of septic abortion. The gravest risk attached to the process of abortion is sepis; infection of the uterine contents may lead to serious pelvic inflammation and to septicæmia. A sterile throat swab should be used to obtain a specimen of discharge either from the vault of the vagina or from the cervical canal with the aid of a speculum when the patient is first seen. This is particularly necessary at present, because it is now common to find organisms which are resistant to antibiotics. The swab should be sent to the laboratory at once for culture and to determine the sensitivity to antibiotics and sulphonamides. Doses of crystalline penicillin, 500,000 units six-hourly, should be given, together with a sulphonamide, until the symptoms and signs subside. When the bacteriological report is available this treatment may be modified according to the organisms found and their sensitivity. It is wise to continue the antibiotic treatment for at least 5 days after the temperature has reached normal. After the temperature has subsided the uterus may be left to evacuate itself if the ovum is dead as it almost certainly will be. These cases of intrauterine infection before

abortion has commenced are almost always due to criminal interference with an instrument which has introduced pathogenic organisms into the uterus.

In cases of incomplete septic abortion the treatment may be by two methods. First, if the temperature is less than 100° and there are no signs of peritonitis it is possible to start giving the antibiotics and sulphonamides at the same time as ergometrine, and then after a short time surgically to evacuate the uterus if necessary. It is common for the temperature and pulse-rate to drop dramatically after the removal of a large piece of placenta which has been blocking the internal cervical os and allowing infected blood clot to collect above it.

Secondly, and particularly if there is established infection with peritonitis, the infection may be treated as described above and, if necessary, a blood-transfusion given (with iron by mouth) to combat the anæmia. When the temperature has been normal for 24 hours the uterus is then evacuated surgically. The theoretical advantage of this line of treatment is that the protecting mechanism, consisting of a zone of plasma cells and polymorpho-nuclear leucocytes in the uterine wall, is left intact while the infection is still present. The disadvantage is that the hæmorrhage may be severe, and dead placental tissue and blood-clot in the uterus are excellent media for the growth of organisms, particularly of the anærobic variety. When clostridial infection is suspected on clinical or bacteriological grounds massive doses of penicillin are given with gas gangrene antiserum. Any dead placental tissue should be removed surgically as soon as possible.

Septic abortion, particularly in virulent infections, may be complicated by a spread of the organisms from the uterine cavity, causing salpingitis, peritonitis, parametritis, or septicæmia. In self-induced abortion the infection may reach the peritoneum directly owing to the passage of an instrument through the recto-vaginal pouch. If the instrument is passed into the cervical canal with the woman in the squatting position, perforation of the fundus may occur, but penetration sideways into the broad ligament is more likely to take place. This may produce acute parametritis. A strange variety of instruments has been used in self-induced abortion, and any of these may be passed by mistake through the urethra into the bladder. In view of the dangers associated with septic abortion it is always advisable to admit these cases to hospital for treatment.

Treatment of missed abortion. All cases of carneous mole eventually undergo spontaneous evacuation, but sometimes it is many months before this happens. It is probably wiser to leave the uterus to evacuate itself spontaneously. If the patient is distressed by the knowledge that she is carrying about a dead fœtus, the uterus may be emptied surgically, using ovum forceps after dilatation of the cervix.

Treatment of habitual abortion. In habitual abortion the cause is usually of maternal origin. It has been suggested that it may be due to deficiency of progesterone secretion, and good results are claimed from the use of progesterone. It is difficult to be dogmatic about this, as there are many conflicting opinions about it. Examination of a vaginal smear or of the cervical mucus may indicate an inadequate progesterone effect, and estimation of the excretion of pregnandiol may also be made. If there is thought to be a deficiency of progesterone treatment may be given by injecting 17α hydroxyprogesterone caproate (Primolut Depot) 250 mg. intramuscularly twice weekly until the 20th week. It is said that other progestogens may have a virilizing effect on a female fœtus as they are partly converted to androgens in the body, and it is also claimed that Primolut Depot does not have this risk. If the basal metabolic rate is proved to be reduced, thyroid deficiency may be the cause of abortion and thyroid extract 30 mg. (½ gr.) daily should then be given.

In cases of habitual abortion a hysterogram should be done to exclude an abnormality of development such as a septate or bicornute uterus, but such a condition is seldom found to be the cause. Fibromyomata of intramural or submucous situation should always be removed if found in a case of habitual abortion. Deep cervical lacerations which involve the internal os may cause miscarriage and should be repaired.

Limitation of activity must be insisted on, and normal bowel action should be encouraged by the use of mild aperients. Coitus must be avoided altogether.

There is much evidence for saying that there is an emotional factor in cases of habitual abortion which may be largely responsible for subsequent miscarriages. It is most important therefore to reassure the patient that she still has a chance of reaching term. The elaborate treatment so often given to these patients may be a potent factor in increasing confidence, thus promoting the chance of a successful delivery.

An occasional case of habitual abortion is due to a deficiency of the internal cervical os. This very rarely is due to a congenital defect. A more likely cause is over-forceful dilatation of the cervical canal for the treatment of spasmodic dysmenorrhœa or as a preliminary to curettage or when emptying the uterus of an incomplete abortion. On other occasions the whole cervix may be lacerated as far as the level of the internal os during labour at term. Such a weakness of the cervical canal causes a failure to support the fœtal membranes when the sac reaches the internal os at the 12th week and after. In these cases the unsupported membranes bulge through the cervical canal and eventually rupture causing an abortion to take place. This type of abortion often occurs between the 20th or 28th weeks of pregnancy. An operation has recently been devised for tying a thick suture of nylon or other substance tightly round the cervix close to

the internal os, beneath the skin covering the vaginal portion. This may be done during pregnancy after the 12th week, or later, and is often very successful in enabling the pregnancy to reach term, when the suture is divided and labour allowed to commence. If strong labour should begin before that time obviously the stitch will have to be removed.

INTRA-UTERINE DEATH OF THE FŒTUS

In addition to those cases in which the fœtus dies during delivery as the result of asphyxia and difficult labour, others are seen in which it dies *in utero* before labour starts. This is usually followed by the expulsion of the fœtus from the uterus. In exceptional cases, however, the dead fœtus is not expelled from the uterus at once, but is retained for months.

CAUSE

The causes of such intra-uterine deaths are imperfectly understood. In a few cases the cause of death is obvious; in others examination of the placenta will point to its being at fault.

The causes of premature fœtal death may be classified under the following headings:

1. Those due to *infections*, such as syphilis. A Wassermann test must be done as a routine early in pregnancy. A positive finding, if confirmed as caused by syphilis, means vigorous treatment of the mother before the child is born, in which case a still-birth as a result of syphilitic changes in the placenta and fœtus will be rare. In undiagnosed cases it is common for the fœtus to be born prematurely and in a macerated state which means that death has occurred some time before labour began. Among the immigrant population a high incidence of positive Wassermann reactions will be found and among these patients it is not possible to exclude syphilis even if they give a history of yaws. Any patient with a positive serological test must be given a course of penicillin early in pregnancy to protect the fœtus. A typical course consists of 10 consecutive daily injections of 1,000,000 units.

Any infective disease which causes a very high temperature may kill the fœtus *in utero*.

2. *General disease*, such as pre-eclamptic toxæmia, essential hypertension, chronic nephritis and diabetes.

One of the most frequent causes of intra-uterine death is toxæmia. Fœtal anoxia is produced by reduction in the maternal blood-supply to the uterus due to spasm of the vessels. Added to this there may be sudden separation of the placenta due to an accidental antepartum hæmorrhage or extensive clotting of maternal blood around the chorionic villi.

Essential hypertension acts in the same way upon the blood-supply to the placenta. It is common in these cases to find a small fœtus whose growth is deficient, and the placenta is often correspondingly small. A super-imposed toxæmia of pregnancy often develops.

Chronic nephritis, if adequately treated in pregnancy, may not result in abortion but when the fœtus becomes viable it is subjected to the risks associated with placental infarction, accidental hæmorrhage and death of the fœtus due to anoxia.

If a diabetic woman becomes pregnant and, particularly if the disease is inadequately controlled, death of the fœtus *in utero* may easily occur.

3. *Malformations of the fœtus* which are incompatible with life.

If maceration is far advanced by the time the fœtus is born it may be impossible to define the cause of death, but gross abnormalities are not uncommonly present.

4. *Postmaturity.* Controversy still rages over this subject but many consider that it is dangerous to allow a patient to go beyond the 42nd week of pregnancy. There are many pitfalls in making the diagnosis of post-maturity. The placenta after term may be less efficient and, if the fœtus is suffering from increasing anoxia, death may occur suddenly without previous warning. The fœtus is at especial risk in these cases if the mother is an elderly primigravida or if she has hypertension.

5. Death of the fœtus can occur as a result of an over-zealous attempt at *external version* which may produce separation of the placenta.

6. *Rhesus incompatibility: Erythroblastosis fœtalis.* Intrauterine death of the fœtus may result from hæmolytic disease (erythroblastosis fœtalis). When a Rh positive man mates with a Rh negative woman and the fœtus is Rh positive, in a small number of cases the mother produces anti-Rh agglutins as a result of immunization against the fœtal blood. These anti-bodies passing through the placenta may cause hæmolysis of the fœtal red cells. Although this sequence of events commonly results in the birth of a live child in whom one form or another of erythroblastosis may be manifest, it may also cause intra-uterine death of the fœtus, especially during the later stages of pregnancy. The first child of such a mating is not usually affected to any considerable degree. Subsequent children suffer from ery-throblastosis when anti-rhesus agglutinins accumulate and increase in potency.

Despite the statements just made it must be realized that the majority of rhesus negative women married to rhesus positive husbands have healthy children without any form of hæmolytic disease.

7. *Placental Insufficiency.* In a few patients unexplained placental insufficiency occurs in successive pregnancies. The fœtus does not grow at the proper rate and intra-uterine death may occur in the later weeks. The

placenta is found to be small, but often appears to be normal in other respects. Even if born alive some of the infants die soon after delivery.

In the absence of any explanation for some of these cases the only advice which can be offered is to rest in bed during most of the pregnancy, with the hope that this will increase the uterine bloodflow. If intra-uterine death has occurred in previous pregnancies delivery before the time at which the deaths occurred is wise, either by induction of labour or by Cæsarian section.

PATHOLOGICAL ANATOMY

The fœtus is usually born in a macerated condition, that is to say its skin is peeling and stained pinkish-brown by the absorption of blood pigment. The whole body is softened and toneless; the cranial bones are loosened and easily movable on one another. The liquor amnii and the fluid in all the serous cavities contain blood pigments. Maceration occurs rapidly and may be advanced within 24 hours of fœtal death; it is not accompanied by an offensive odour.

If maceration does not occur the fœtus may dry up and mummify, resulting in a so-called fœtus compressus or fœtus papyraceus. This sometimes occurs when one of twins dies: the dead fœtus is then retained, and is born with the membranes of the healthy child.

SYMPTOMS AND DIAGNOSIS

The patient may notice that the fœtal movements have not been felt for several days, and the breasts may diminish in size and cease to be tender. Vomiting and nausea, if present, may suddenly stop.

On examination suggestive signs may be obtained, such as—

Absence of fœtal heart-sounds. Before the 24th week the heart-sounds cannot be heard even in a normal case; but after that period of pregnancy has passed, if a skilled observer repeatedly fails to hear them on careful auscultation it will be strong presumptive evidence of fœtal death. This is confirmed if the heart-sounds have been previously heard by the same person. The absence of fœtal movements may be noted at the same time.

Cessation of growth of the uterus. The uterus may be found to be smaller than the duration of the amenorrhœa would warrant, but this is only significant if the previous cycles were regular. A more accurate test is to note how much alteration takes place in the size of the uterus during a fixed period, e.g. a month. To do this the bladder should be emptied and the level of the fundus should be accurately noted. The patient is then examined week by week, and the level of the fundus noted. If enlargement is not observed in 4 weeks this is almost certain evidence that a dead fœtus is being retained *in utero.*

In some cases the uterus not only ceases to enlarge but gets smaller owing to the absorption of the liquor amnii.

Alteration in the consistency of the uterus. If the liquor amnii is absorbed to any great extent the uterus will become firmer and will lose its elasticity.

Sometimes a free secretion of colostrum in the breasts may occur a few days after the death of the child.

On vaginal examination the discharge of cervical mucus may be coloured brown by altered blood: this is not a diagnostic sign of fœtal death, as it also occurs in concealed accidental hæmorrhage and other conditions. A radiograph will show overlapping and disalignment of the skull bones (Spalding's sign) and occasionally the presence of gas bubbles in the fœtal heart and great vessels. Spalding's sign is not evident for about a week after fœtal death but gas formation may be seen after only two days. Biological or immunological tests for pregnancy may become negative within a week after the death of the fœtus, but the tests are not reliable in such circumstances. Intra-uterine death of the fœtus is accompanied by a fall in the amount of free œstrogen in the blood.

It will be seen that death of the fœtus is difficult to diagnose from a single examination of the patient, and usually the safe course will be to watch the patient for a few weeks before deciding that the child is alive or otherwise. Very little importance should be attached to the patient's statements about cessation of fœtal movements, since patients often confuse fœtal with intestinal movements.

TREATMENT

In the majority of cases labour soon follows death of the fœtus. There are, however, cases in which the signs of fœtal death are clearly present, but labour does not occur spontaneously even after several weeks. In these cases there is no urgent call for interference, unless the complication of hypofibrinogenæmia develops (see p. 468). If the patient becomes greatly distressed when she knows the fœtus is dead, then labour can be induced, but surgical methods of induction are unwise because of the risk of anærobic uterine infection due to growth of bacteria in the dead fœtal tissues if labour does not follow quickly. Quinine by mouth, 600 mg. (10 gr.) three times daily, is not very effective. The injection of hypertonic saline or glucose solution into the amniotic cavity has been recommended, but infection has followed in a few cases. The safest method of induction is by means of an intravenous infusion of oxytocin. In these cases (in which the fœtus is not to be considered) higher concentrations may be used than are usual (see p. 573), but the uterine action must be carefully observed.

HYDATIDIFORM OR VESICULAR MOLE

A HYDATIDIFORM mole consists of a collection of vesicles of varying size resulting from abnormal development of the choronic villi. The vesicles are arranged on a number of stalks which spring from the surface of the chorion and each represents an original villus. These original villi branch, and the branches show the same vesicular formation, so that they come to resemble

FIG. 80. Microscopical section of hydatidiform mole. $\times$ 75.

strings of beads. It is one of the rarer complications of gestation. It has been met with in extra-uterine pregnancy, also accompanying a normal twin, and even in a portion of the placenta of a healthy fœtus.

MORBID ANATOMY

It is essentially a chorionic neoplasm. The change in the chorionic villi begins during the first 2 months of pregnancy, when the whole chorion is covered with villi. The amniotic sac is usually indistinguishable, and an embryo cannot be found.

Owing to the enlargment of the villi, the chorion takes up as much room as the whole ovum of a normal pregnancy. In many cases the size of the uterus is greater than that of a normal pregnant uterus corresponding to the same period of amenorrhœa. This increase in size is chiefly found in cases in which concealed hæmorrhage has occurred into the uterus owing to the separation of the chorion. The undue increase in size may occur in a short time, and may lead to distension of the uterus, accompanied by pain. In

FIG. 81. Hydatidiform degeneration, showing thinning of the uterine wall.

other cases there may be no excessive enlargement of the uterus which may be normal or smaller in size than the dates would suggest. Occasionally a fœtus is born normally at term and part of the placenta is found to have undergone vesicular changes.

Vesicles vary in size from the microscopic to about 3 cm. in the longest diameter. The largest vesicles are usually elliptical, only the smaller ones having a spherical outline.

Microscopically, the vesicles are seen to consist of the usual structure of a chorionic villus, but show an excessive proliferation of both layers of the trophoblastic covering (chorionic epithelium consisting of Langhans layer and syncytium), accompanied by an œdematous or hydropic degeneration of the connective tissue. There is, therefore, at the same time, proliferation and degeneration taking place in the villus. In the smaller vesicles the connective tissue of the villus can still be recognized, but its cellular elements are degenerate and are widely separated from one another by fluid accumulations. In the larger vesicles the connective tissues and the blood vessels have quite disappeared, nothing remaining but the cyst wall composed of chorionic epithelium containing clear fluid. This fluid was formerly thought to result from mucoid or myxomatous degeneration of the

connective tissue of the villus. However, the fluid does not contain mucin and the condition is a primary œdematous change with secondary necrosis of the connective tissue.

Both the syncytio-trophoblast and the cyto-trophoblast undergo proliferation forming massive buds. These buds may be large enough to be detected by the naked eye. Such masses of chorionic epithelium attached to the vesicles are almost indistinguishable from the cell-masses which characterize the malignant growth known as a chorion-epithelioma.
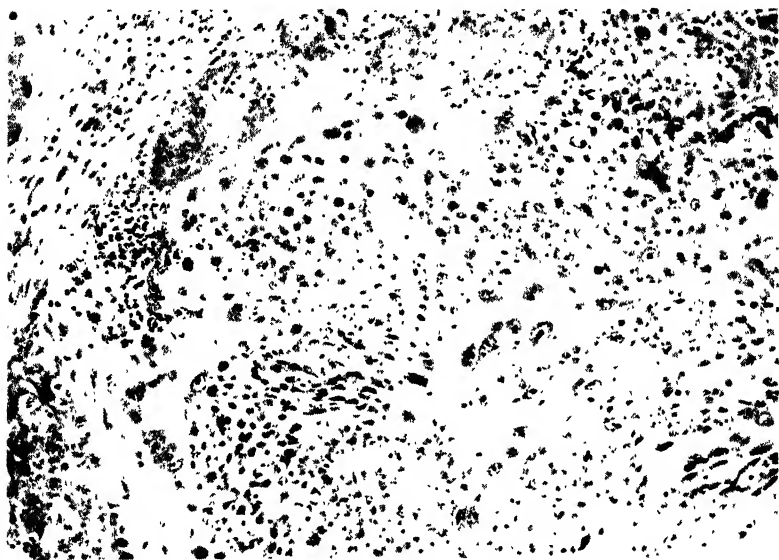
FIG. 82.   Microscopical section of chorion-carcinoma × 75.

This active proliferation of the chorionic epithelium is the essential feature in the pathology of a hydatidiform mole, and must be looked upon as the first manifestation of some unexplained primary disease of the ovum itself. The relatively enormous increase in the two layers of the trophoblastic covering gives to the mole a much increased power of eroding the uterine wall. Clinically important results take place in consequence, and in some cases the villi penetrate completely through the decidua and perforate the uterine muscle. Even the peritoneum may be reached and broken through, so that hæmorrhage occurs into the abdominal cavity. This power of deep penetration is the distinguishing feature of the so-called malignant hydatidiform mole, better named the invasive or penetrating mole. Thus every gradation from a simple hydatidiform degeneration of the chorion up to the penetrating mole can be found. Microscopically the tissues from all

these varieties are alike, and there is no means of deciding from its histology which mole is simple and which penetrating.

Bilateral theca-lutein cysts are frequently present in the ovaries and may be quite large. They tend to disappear in time after the mole is removed.

When this condition of the ovaries was first noticed, it was suggested that the increased amount of lutein tissue was responsible for the luxuriant proliferation of the trophoblast. The modern view is that the hydatidiform mole is a primary disease of the ovum, and that the ovarian changes are secondary. Aschheim and others have shown that the amount of gonadotrophin excreted in the urine is many times greater than in normal pregnancy.

SYMPTOMS

The chief symptom is bleeding. This has been seen as early as 6 weeks after the last normal period, but usually occurs in the 3rd or 4th month of gestation. Sometimes the abnormally large size of the uterus and the absence of foetal movements may attract attention. Abdominal pain may be complained of, especially if the mole is complicated by concealed hæmorrhage. Symptoms of toxæmia are present in a considerable proportion of patients who have large hydatidiform moles, and even eclampsia may occur. Vomiting may be excessive, and in many cases the patient does not feel or look well.

SIGNS

The uterus is generally larger than in a normal pregnancy of the same duration, but not always so and indeed, in some cases, it is smaller. The consistence of the uterus is usually tumid but may be that of normal pregnancy. External ballottement cannot be obtained or foetal heart-sounds heard, except in the very rare cases of twin pregnancy in which only one ovum is affected.

On vaginal examination a foetus cannot be felt, but there may be the usual signs of abortion, namely, slight dilatation of the cervix and haemorrhage. Later, when the cervix is sufficiently dilated to admit the finger, the mole can be felt and the diagnosis is obvious. The patient may have a slight fever and signs of toxæmia may be present.

DIAGNOSIS

Hydatidiform mole has to be differentiated from threatened miscarriage in an otherwise normal pregnancy. The main points are the size of the uterus, the absence of signs of the foetus, and the passage of the vesicles *per vaginam*. Hydramnios or multiple pregnancy with a threatened miscarriage may be mistaken for a hydatidiform mole. Pregnancy in the

presence of fibroids will give rise to a uterus too large for the period of amenorrhœa. Similarly an ovarian tumour impacted in the recto-vaginal pouch will push the uterus up to an abnormally high level in the abdomen.

In cases associated with hypertension, albuminuria, œdema, and vomiting, the absence of the signs of fœtal life should suggest that the diagnosis is one of hydatidiform mole, and not one of ordinary pregnancy with toxæmia which is almost unknown at such an early stage. An X-ray picture does not show fœtal bones.

The biological tests for pregnancy have proved to be of value in diagnosis, because the test is positive with diluted urine. The test is also positive in a higher dilution than normal in cases of hydramnios and twin pregnancy. The diagnosis of hydatidiform mole can be very strongly suspected when the test is positive with a dilution of 1 in 100; it can be made with confidence when the test is positive in a dilution of 1 in 500. The test may remain positive with undiluted urine for some weeks after abortion, but if diluted urine continues to give a positive result it strongly suggests the possibility of chorion-carcinoma. Palpation of bilateral ovarian cysts in the presence of a uterus which is too large for the duration of pregnancy is most suggestive of hydatidiform mole. These must not be removed because they will become absorbed after evacuation of the vesicular mole.

Recent work on the diagnosis of pelvic tumours by the reflection of ultrasonic waves has shown that there is a characteristic pattern in cases of hydatidiform mole. In the few centres in which such diagnostic aids are available this investigation may be most helpful.

PROGNOSIS

Danger to life may arise from hæmorrhage. During expulsion and still more during surgical evacuation of the mole there may be serious hæmorrhage, and as small pieces are adherent to the uterine wall, the uterus may not retract well, and so hæmorrhage of some severity may ensue and may be fatal to the already exsanguinated patient. An attempt to evacuate the uterus *per vaginam* before uterine contractions have begun is a dangerous procedure and will give rise to mose severe hæmorrhage.

Sepsis is a frequent complication owing to the fact that the uterus rarely empties itself completely, and the introduction of the fingers or instruments is required to separate adherent portions.

Erosion of the uterine wall. When the villi penetrate deeply, the wall of the uterus may be so thin that hæmorrhage may occur under the peritoneum, or the uterus may rupture. There is thus a considerable risk of perforating the uterine wall if removal of the mole becomes necessary.

Chorionic carcinoma. This extremely fatal, though rare, growth is found more frequently after hydatidiform moles than after any other type of

pregnancy and, therefore, the possible occurrence of chorion-epithelioma must be taken into account when estimating the risks of hydatidiform mole.

TREATMENT

The treatment of this condition is to empty the uterus, and to promote contraction and retraction. In cases in which the cervix is already dilated, spontaneous evacuation of the whole or greater part of the mole may be achieved. Every opportunity should be given to encourage expulsion by the uterus itself, provided that hæmorrhage is not excessive. Digital exploration will be necessary to be sure that the mole has been completely expelled. Ergometrine or oxytocin should be used as required. So far as possible, the mole is to be squeezed out from above rather than pulled out from below.

When it is found necessary to extract the mole or remaining portions of it from the uterine cavity the fingers can be used. The greatest care must be exercised in scraping with the fingers, as the uterine wall may be perforated all too readily when villi have penetrated deeply. The use of ovum forceps may be employed if the uterus is contracting well. It is helpful to douche from time to time and to wipe out the cavity with gauze on a sponge holder when the uterus is sufficiently contracted. Whilst the wall is being gently scraped with the fingers, the external hand should be applied to the abdomen to steady and define the uterus. The operation is one of considerable severity and it may take a long time to complete.

A diagnosis of hydatidiform mole may be made by quantitative biological pregnancy tests and clinical considerations before the extrusion of vesicles and before the cervix is dilated. In these cases the alternative lines of treatment are artificial dilatation of the cervix either with laminaria tents or ordinary metal dilators and evacuation of the mole *per vaginam*, or abdominal hysterotomy. Most obstetricians prefer the former, but when the uterus is equivalent in size to a 16 to 20 weeks pregnancy and uterine contractions have not commenced it is often wiser to evacuate the mole by the abdominal route. If the patient is near the menopause, hysterectomy should be considered, particularly as the development of chorion-epithelioma is comparatively high in women over 40.

If the lochia continue coloured with blood at the end of 2 weeks, the uterus should be curetted and the scrapings submitted to an expert pathologist. In any event it is wise to curette the uterus thoroughly two weeks after a spontaneous evacuation of a vesicular mole because vesicles almost always remain embedded in the decidua and cause the pregnancy test to remain positive. Chorion-epithelioma secondary to hydatidiform mole does not, however, always lead to persistence of red discharge. It does not necessarily persist when the growth lies within the wall of the uterus rather than projecting into its cavity. Hence it is sound practice to have a biological test for

pregnancy made every month, commencing at the 4th week after the evacuation of the mole. When the test is negative on several successive occasions the patient may be regarded as cured.

For the diagnosis and treatment of chorionic carcinoma the reader is directed to Ten Teachers, *Diseases of Women*, Chapter XXXI, p. 311.

HYDRAMNIOS AND OLIGOHYDRAMNIOS

HYDRAMNIOS means the presence of an excessive quantity of liquor amnii. It is difficult to say exactly what the amount must be in order to merit the term *excessive*, because the normal quantity at term varies from 300 to 1500 ml. (10 to 50 ounces) with an average of 600 ml. (20 ounces). Probably quantities less than 3000 ml. (100 ounces) would not be recognizable as hydramnios on abdominal examination.

For the composition of the fluid and the theories as to its origin see p. 30.

Hydramnios almost always occurs in the second half of pregnancy. Its appearance before this strongly suggests the presence of uniovular twins. Hydramnios occurs more often in multiparæ than primigravidæ and the source of the excess may be fœtal or maternal in origin.

Fœtal causes are as follows:

(a) There may be an excess of liquor in cases of twin pregnancy, when usually only one sac is distended.

(b) Fœtal abnormalities. The commonest is the anencephalic monster which probably is often incapable of absorbing liquor through the intestinal tract.

The fœtus may have an œsophageal atresia with inability to swallow. This possibility must always be borne in mind if regurgitation occurs in a baby just after birth when there has been an excess of liquor.

Other gross abnormalities of development may be present in cases of hydramnios and spina bifida is common.

(c) Very occasionally a chorio-angioma of the placenta causes hydramnios.

(d) Hydrops fœtalis may be complicated by hydramnios.

Maternal diabetes is often associated with hydramnios. (See p. 277.) Glucose may be present in excess in the liquor, but this is only found in a proportion of the cases and does not explain the hydramnios.

VARIETIES

There are two varieties, chronic and acute.

Chronic hydramnios is the more common form and is seen more often in multiparæ than in primigravidæ. It is slowly progressive and is not usually apparent until the second half of pregnancy. When hydramnios occurs early in the second half of the pregnancy it is often associated with

suitable local anæsthetic a spinal needle is pushed through into the amniotic cavity. The liquor will usually run out freely, but it may be necessary to aspirate, as occasionally the needle may become blocked with vernix. Up to 2 litres may be safely removed provided that it is only allowed to escape slowly. Although there is some risk of labour following this operation a few patients will continue in comfort to term. Unfortunately in most cases the excess of fluid quickly returns. The operation may be repeated as necessary There is always a slight risk of perforating a placental vessel and producing hæmorrhage of fœtal origin into the amniotic sac.

When a very great deal of liquor amnii is present it is risky to rupture the membranes from below and allow a large quantity of fluid to escape suddenly. The placenta may separate producing a severe antepartum hæmorrhage.

Deficiency of liquor amnii
(Oliogohydramnios)

A very small amount of liquor amnii is very unusual. In a few cases there is no liquor. In most there is some abnormality of the urinary tract of the fœtus of which renal agenesis is the most well recognized. In renal agenesis there is often a typical facies and the total clinical picture in the ·baby is called Potter's syndrome. Looked at from the side the nose has a hook shape similar to that of a parrot's beak, and the lower jaw is underdeveloped with the upper jaw over-riding it. The ears are abnormally low on the side of the head. A further clue to the abnormality may be gleaned from examination of the fœtal surface of the placenta where tiny white beads may be seen studded all over the amnion (amnion nodosum). On section these small plaques are shown to be islands of degenerate squamous epithelium resting on a bed of flattened amniotic cells. It seems likely that these nests of squamous cells come from the surface layers of the skin of the fœtus, whose skin after birth always looks red and dry. Because of the dry environment in which it has lived it may be that the squames are rubbed off and settle on the amnion.

When the liquor is scanty there is no room for the fœtus to turn round, so if it presents by the breech early in pregnancy it will stay that way. In fact the percentage of breech presentations with oligohydramnios is extremely high and external version is obviously impossible. The complete picture of renal agenesis is therefore a breech presentation in a tight small uterus, virtually no liquor at delivery, amnion nodosum and a baby with Potter's syndrome with typical facies and red dry skin. The baby inevitably dies, usually within 48 hours of birth.

Emphasis has been placed on the association of oligohydramnios with renal abnormality but it should be noted that it can occur without

demonstrable abnormality in the baby, and in not all cases of renal agenesis is there total absence of the liquor.

A more common cause of some degree of deficiency of the liquor is postmaturity. The volume of the liquor tends to decrease after term so that if delivery is greatly beyond the expected date very little liquor may be left (p. 67).

DISEASES ASSOCIATED WITH PREGNANCY

PYELONEPHRITIS AND CYSTITIS DURING PREGNANCY

Definition. Pyelitis means inflammation of the pelvis of the kidney, but infection of the pelvis is almost invariably accompanied by infection of the renal parenchyma, at least to some degree; the term pyelonephritis is therefore correct. In most cases the ureter is also inflamed. The disease usually occurs between the ages of 20 and 30 years, and is far more frequent during the first pregnancy. It has been found in 1 per cent of unselected antenatal patients. The symptoms appear most commonly during the 5th and 6th months of pregnancy, but they may arise at any time, often in the puerperium between the 6th and 10th days, but earlier if there has been pyelitis in pregnancy.

Relapses during the same pregnancy may take place; and attacks in subsequent pregnancies have been noted in about 10 per cent of cases.

MORBID ANATOMY

The condition is rarely fatal. The lesions of the milder cases, therefore, are not known and the following description refers only to the severe cases.

The kidneys. In 50 per cent of cases the infection is confined to the right side, in 16 per cent to the left, and in 34 per cent of cases both sides are involved.

The kidney is of a pale colour and softer than the normal. It is usually enlarged by the distension of the pelvis which is nearly always present. The cut surface shows some dilatation of the pelvis, which is injected, thickened, and roughened. Within the renal cortex small abscess cavities are frequently discovered and streaks of pus may be seen radiating outwards in the medulla from the renal pelvis. Microscopic section shows acute inflammatory reaction which extends to a greater or less degree into the renal parenchyma.

The ureters. In addition to the dilatation of the ureter and renal pelvis which occurs in normal pregnancy (see below) the ureter shows acute inflammation of its epithelial and muscular coats.

The bladder may not show any abnormality. In a certain proportion of cases, however, there are signs of cystitis. This may have preceded the attack of pyelitis, or may be the direct result of it.

Changes in the renal pelvis and ureter in normal pregnancy

Intravenous pyelography, which was freely performed during pregnancy in the past, before the possible fœtal hazard was recognized, shows that dilatation of the ureters and renal pelves is a common accompaniment of pregnancy, and it has been shown that in about 80 per cent of pregnant women there is marked stasis in the right ureter and to some extent in the left ureter also. The dilatation extends down as far as the brim of the bony pelvis; below that level the ureter often appears normal. There is at present little evidence that ureteric reflux from the bladder occurs during pregnancy, but this is a possible explanation of ascending infection. The dilatation may be caused in part by pressure of the enlarged pregnant uterus on the ureter at the brim of the pelvis. The right ureter is more likely to be involved on account of the tendency of the uterus to incline towards the right side, and to twist upon its vertical axis so that the left side lies more to the front. The right ureter also lies further from the middle line than the left, and is therefore less protected by the projection of the sacral promontory. Pyelograms have proved the presence of dilatation often associated with marked kinking which together cause urinary stasis, and encourage the growth of micro-organisms.

In addition to mechanical factors causing dilatation of the ureter, there is evidence to suggest that there may be atony of the ureteric musculature during pregnancy. It has been shown that the intra-ureteric pressure is not increased. It has further been suggested that this atony is caused by the inhibitory effect of progesterone upon the posterior-pituitary hormones.

The infecting organism. An organism of the *Escherichia coli* group is present in nearly 80 per cent of cases. The organism has been obtained not only from the bladder, but directly from the kidney by ureteral catheterization, contamination from the bladder being thus excluded. Other organisms are occasionally found, such as the *Streptococcus fæcalis*, *B. proteus* or *Staphylococcus*.

The path of infection. There are two possible paths of infection by which the organism reaches the kidney:
1. By the blood-stream (descending infection).
2. By the urinary tract (ascending infection).

1. *By the blood-stream.* This method of infection is considered to be the most likely. Even during health the body may contain a few wandering organisms which have entered the blood-stream, possibly from the intestinal tract. In health they are excreted by the kidneys without causing symptoms. Should the kidneys be damaged there is a liability that these organisms may settle down in the damaged tissue. Such damage may exist

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in the urinary tract during pregnancy, as shown by the dilatation of the ureters and renal pelves. This view is supported by experiments in which ureter̂s of rabbits have been tied, and *E. coli* and streptococci have been injected into the veins of the ear. In every case pyelonephritis has followed, and the causative organism has been recovered.

Additional support is given to this view by the observations that bacilluria occurs in 10 per cent of pregnant women, *E. coli* being found in 7·5 per cent, although there is no evidence of urinary infection. It is argued that these organisms are in process of excretion by the kidneys. Yet the bacilli can seldom be grown from the blood, even if the blood is examined when the symptoms are acute, and in some cases they may come from a renal focus which has persisted from a previous infection.

2. *By the urinary tract.* This view supposes that the organisms ascend to the kidney along the course of the bladder and ureters. Those who accept this view point out that some case of acute pyelonephritis follow an attack of gastro-enteritis and believe that organisms may ascend the short female urethra. Organisms can certainly be introduced if a catheter is passed. That such contamination occurs is not very probable, but it is a fact that cystitis occasionally precedes the pyelitis. It has been conclusively demonstrated that even in the absence of any clinical evidence of cystitis the bladder may contain bacteria. The question that next arises is, can they ascend to the kidney? This is certainly possible if there is any reflux from the bladder through the ureteric orifice, and some believe that such reflux is common during pregnancy.

It has also been suggested that the organisms travel up in the peri-ureteral lymphatics. If one ureter of a rabbit is ligatured, and coliform bacilli are injected into the bladder, the rabbit will develop a pyelonephritis on the same side, and the bacilli can be seen within the lymphatics of the ureter. It is also theoretically possible for organisms to reach the per-urethral lymphatics from an infected cervix uteri.

It is probable that infection may occur by means of any of the paths which have been mentioned, especially if there is any tendency to urinary stasis in the pelvis of the kidney.

<div align="center">SYMPTOMS</div>

Pyelitis in pregnancy may be acute or chronic.

(a) *Acute form.* The patient, usually a primigravida at about the 24th week of pregnancy, is suddenly seized with an acute attack of abdominal pain, which is felt in the lumbar or iliac region of one or both sides, generally the right. The temperature rises suddenly to about 103° to 104°F (40°C), and may be accompanied by a rigor; the pulse-rate is rapid and

often remains at about 120 per minute for several days. The patient frequently appears profoundly ill, and complains of severe vomiting and sometimes of constipation. It is a characteristic of the disease, however, that the patient improves rapidly in appearance after the rigor is over. The abdomen may be distended and is tender, especially over the region of the affected kidney.

(b) *Chronic form*. In this form the symptoms are not so characteristic, and the mode of onset is variable. There may be a gradual onset with malaise and increasing lumbar pain, frequency, gastro-intestinal disturbances, or with symptoms suggesting pleurisy and pneumonia. The temperature is slightly raised and irregular; on palpation the kidney may be tender and feel enlarged. The tenderness of the kidney often subsides after the free passage of pus in the urine, and there is a tendency for the pain to subside in one lumbar region and later to develop upon the opposite side. The attack in some cases is extremely mild; there may be pain but no other symptom, or the patient may have rigors without any apparent cause.

The urine. In severe cases at first the urine is diminished in amount and of high specific gravity. Later the amount is much increased, owing to the large amount of fluid given in the course of treatment. The urine in the earliest stages contains only bacilli but soon the urine becomes turbid, contains pus and flocculent débris; the reaction is almost invariably acid. It is seldom offensive. A pure culture of the coliform bacillus is usually obtained. The centrifuged deposit contains large quantities of these organisms, pus cells, epithelial cells, some red blood-corpuscles, and albumin.

The blood. The white cell count is raised beyond that which is regarded as normal during pregnancy; in many cases there is a leucocytosis of from 20,000 to 30,000 per c.mm. affecting chiefly the polymorphonuclear cells.

DIAGNOSIS

The diagnosis is based upon the occurrence of a raised temperature, bacilluria, pyuria, and the presence of abdominal pain and tenderness in the situation of the kidney or down the line of the ureter. It should always be thought of when there is renal tenderness during pregnancy. Care must be taken, when examining the kidney, that the affected side is uppermost, the patient being on her side, so that the uterus does not obscure the palpation of the kidney. The diagnosis is confirmed by examination of a midstream specimen of urine. Part of the specimen is sent to the laboratory for bacteriological examination, including the testing of any organism found for sensitivity to the various antibiotics. The rest of the specimen may be examined immediately under the miscroscope for pus cells. The discovery of pus cells is sufficient for preliminary diagnosis and will permit treatment to be begun while the laboratory report is awaited.

The differential diagnosis may include:

(1) Other conditions causing acute abdominal pain during pregnancy, such as appendicitis, torsion of an ovarian cyst, or red degeneration of a fibroid. The onset of pyelonephritis may sometimes be very acute with vomiting, and there may be tenderness in the right iliac fossa or even rigidity, so that the clinical picture may closely simulate that of appendicitis. However, in acute pyelonephritis the temperature is often higher (102° or more) than is seen in appendicitis, and rigors often occur which are rare in appendicitis. Fetor of the breath does not usually occur, and the tongue is cleaner than in appendicitis. If the urine is properly examined a mistake is unlikely.

In cases of torsion of an ovarian cyst or of red degeneration of a fibroid a tender swelling can usually be felt.

Cases of pneumonia or pleurisy occasionally give rise to diagnostic difficulty, for in these conditions pain arising from the right lower lobe or related pleura can be confused with renal pain. In all cases the chest should be properly examined. Epidemic myalgia affecting the diaphragm (Bornholm disease) may also cause confusion, but in all these conditions the urine does not contain pus cells.

(2) Vomiting may be the predominant presenting symptom in cases of pyelonephritis, and dysuria may be absent. In any case of vomiting in pregnancy after the first trimester the urine should be examined for pus cells.

(3) The differential diagnosis of proteinuria is discussed on page 173. There is unlikely to be confusion in cases of acute pyelonephritis; it is more likely that chronic pyelonephritis will be mistaken for pre-eclamptic toxæmia or nephritis.

(4) A few cases will present with pyrexia and little else, and the urine should be examined carefully in any case of undiagnosed febrile illness.

(5) In chronic pyelonephritis anæmia frequently occurs, and in cases of anæmia which do not respond to treatment this possibility should be remembered.

TREATMENT

The patient must be put to bed in order to obtain rest and for the relief of pain. If the right kidney is the one affected, she will obtain more relief if she lies mainly upon the unaffected side, with the knees flexed to relax the abdominal muscles.

In the acute phase a large fluid intake is helpful in flushing out the kidneys and carrying away infected material, and 5 pints of barley water or fruit juice in water may be given daily.

Treatment with sulphonamides is begun at once. An initial dose of sulphadimidine 3 G. is followed by 1 G. six-hourly. When the laboratory

report on the infecting organism is available the treatment may be recog-sidered, but in the usual case of infection with *E. coli* a clinical response to sulphonamides is to be expected within 3 to 5 days. In acute cases a mixture containing potassium citrate 2 G. and sodium bicarbonate 2 G. is given two hourly until the urine is alkaline, and then at such intervals as are required to keep it so. It is generally found that as soon as the reaction of the urine becomes alkaline the patient loses her pain, and the temperature falls, although the bacillus is still to be found in the urine.

A few cases are found to be due to organisms which are insensitive to sulphonamides. In every case the laboratory reports must be considered but it is usually found that infection with *Streptococcus fæcalis, B. Proteus* or staphylococci will respond to oral ampicillin 250 mg. six-hourly, or to streptomycin 1 G. daily.

Surgical treatment. In the past a few cases which did not respond to the drugs then available were treated by drainage of the renal pelves by the passage of ureteric catheters, which were left in place for some hours. Such intervention would hardly ever be required today.

The simplest method of allowing the pus free exit from the kidney is to remove the ureteric obstruction. This might be done by terminating the pregnancy, but it must be emphasized that this is hardly ever necessary before the fœtus has reached the 36th week of pregnancy. After that in-duction of labour may be considered in any case in which there is delay in response to treatment.

Urinary infection during the purperium

The symptoms appear between the 6th and 10th days as a rule, and are frequently accompanied by rigors. This is now the most common cause of fever in the puerperium. In some cases it follows pyelonephritis during pregnancy, but in many cases it is due to organisms introduced by catheterization during labour. The infection may be confined to the bladder, but in other cases the upper urinary tract is also involved.

PROGNOSIS

In the majority of patients with suitable treatment an immediate im-provement takes place, and within a few days the pain subsides, the temper-ature falls, and the urine contains less pus. In the past, before sulphon-amides and antibiotics were available, there were occasional cases of pyonephrosis and of multiple small abscesses in the renal parenchyma, and abortion and premature labour were not infrequent sequels of severe infection. All these events are now rare, but we have come to realize that the acute infection is often followed by further attacks which may continue for many years, and that sometimes chronic pyelonephritis may be an

insidious, progressive and persistent disease, leading to gradual destruction of the renal parenchyma. Interstitial fibrosis occurs, and the kidney shows irregular scarring and contraction. Histological examination shows patchy areas of fibrosis and of round cell infiltration in which both glomeruli and tubules may show ischæmic atrophy, and other nephrons are distended from the obstruction. The important sequel is hypertension, when further arteiolar changes occur in the kidney, and eventually uræmia may occur.

It is important that recurrent or persistent pyelonephritis should be treated effectively. In any suspicious case, and indeed in any patient who has had pyelonephritis during pregnancy, the urine should be examined repeatedly for pus cells and organisms. If these are found an intravenous pyelogram should be carried out after the pregnancy, but in fact impairment of structure or function will seldom be found until the disease has continued for some years.

If excretion of pus cells or bacilli continues, even intermittently, every attempt must be made to give adequate treatment with antibiotics or long-acting sulphonamides. In rare instances of severe unilateral disease nephrectomy may eventually be necessary to prevent or treat hypertension.

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NEPHRITIS (see p. 206)

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ANÆMIA IN PREGNANCY
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Physiological changes

During pregnancy the blood volume is increased by about 25 per cent, but there is a relatively greater increase in the volume of the plasma than of the red cells. The greater increase in the plasma leads to a fall in the red cell count and the hæmoglobin concentration in late pregnancy, although the total mass of hæmoglobin in the body is increased by about 15 per cent. The increase in blood volume is maintained until shortly before term when there is an appreciable fall, but the original non-pregnant level is not reached until about six weeks after delivery. The degree of increase in the blood volume in pregnancy varies greatly; some patients show only a slight change whereas in other cases it may approach 50 per cent.

Recently doubt has been thrown on the purely physiological explanation of the fall in hæmoglobin concentration which is observed in so many pregnancies. Although it is agreed that hæmodilution occurs, in many cases a more important explanation for the fall in hæmoglobin concentration is relative iron deficiency. Many published figures give a hæmoglobin level of 11 g./100 ml. (75 per cent) as being the lower limit of normal during pregnancy, yet it has been shown that if additional iron is given to pregnant

women the hæmoglobin concentration does not fall to the same extent, and many authorities now regard any concentration below 12·6 g./100 ml. (85 per cent) as abnormal.

The normal daily intake of iron in a non-pregnant woman is about 1·5 mg. and this balances the loss in the urine and fæces, from desquamation from the skin, and from the menstrual loss. Menstrual loss varies greatly, but averages 12 mg. per month.

If a woman is to maintain her iron balance during pregnancy she needs to absorb about 700 mg. of iron to provide 350 mg. for the fœtus, 100 mg. for the placenta, and 250 mg. for her own increased hæmoglobin mass. She will save about 100 mg. of iron because menstruation ceases, so that the total absorption during pregnancy must *exceed her normal uptake* by about 600 mg. or over 2 mg. per day. The increased requirement is not spread uniformly over the whole of pregnancy, as the fœtal uptake is far greater in the last trimester, and the additional requirement may reach 12 mg. per day in late pregnancy.

There will be a loss of iron from blood loss during delivery and in the lochia, say 150 mg. and a further deficit of about 150 mg. during lactation, and these losses will use up the increased hæmoglobin mass which has been built up during pregnancy.

Although a good diet may contain 14 mg. of iron daily (and a poor diet will contain much less) only a proportion of this is absorbed and the intake is likely to be far below the increased need. During pregnancy both the power of absorption from the intestine and the iron binding capacity of the serum are increased. It has been suggested that the reduction in gastric acidity which occurs in pregnancy will interfere with the absorption of iron, but this is improbable, as iron is best absorbed in the duodenum and upper jejunum. About 35 per cent of the body iron (1000 mg.) is in the cells of the reticulo-endothelial system in the form of hæmosiderin, and this forms a reserve. Only when the iron reserves are depleted will the serum iron level fall. Not only may there be a deficiency of iron in the diet during pregnancy but many women start pregnancy with poor iron reserves. Successive pregnancies will accentuate any deficiency. In several large cities between 10 and 20 per cent of women have been found to have hæmoglobin levels below 10 g./100 ml. (68 per cent) during pregnancy, and in some backward countries the incidence of severe anæmia may be even higher.

An excellent case can therefore be made out for the routine administration of additional iron during pregnancy, especially after the first trimester when any morning sickness has passed. The cheapest form of iron given by mouth is ferrous sulphate tablets, 200 mg. (3 gr.) three times daily with meals. Some patients find that this preparation causes gastro-intestinal symptoms, and for them ferrous gluconate tablets, 300 mg. (5 gr.) three

times daily may be used. There is no evidence that the addition of ascorbic acid is of value, and preparations containing this substance are expensive.

Regular estimations of the hæmoglobin concentration are an essential part of antenatal care. The blood should be examined at the first visit, and checked again at the 30th week. The colour and appearance of the patient are completely unreliable as an index of the hæmoglobin level.

Iron deficiency anæmia

In this country by far the commonest type of anæmia during pregnancy is that due to iron deficiency, and it may be of any degree. In many of the slighter cases the patient makes no complaint, although when the anæmia is treated and her hæmoglobin level rises she may notice that the listlessness that she took for granted has disappeared. In the severe case the patient may look pale (although this is a most unreliable sign), and she may have noticed tiredness, increased breathlessness, palpitation, fainting or headache. There may be œdema of the ankles.

Many cases are only discovered after routine examination of the blood. In all such cases the patient should be asked whether she has been taking the iron tablets prescribed for her. Although she may declare that she has, if she is then asked whether she needs a fresh supply the discovery may be made that she has a large number of tablets, which would not have been the case had they been regularly taken.

Apart from its adverse effect on the general health of the mother during pregnancy, anæmia greatly increases the risk should hæmorrhage or shock occur unexpectedly during labour, and a determined effort must be made to rectify a low blood count before term is reached. Because of the hæmodilution which occurs during pregnancy the diagnosis of anæmia is not always easy, although if there is any doubt a patient should always be regarded as anæmic. Cases with iron deficiency anæmia not only show a low red cell count and hæmoglobin concentration, with a low colour index and mean corpuscular hæmoglobin concentration, and in severe cases polychromasia in the film, but also a low mean corpuscular volume, a low serum iron level. In practice all these observations are not made as a routine, and in many patients the diagnosis is made by observing a satisfactory response to treatment with iron. But if there is no quick response, or if the anæmia is severe (hæmoglobin less than 9 g./100 ml.) then a complete blood count is required, and sometimes a marrow puncture (see below). In Negro patients the possibility of sickle cell anæmia must be remembered, and patients from tropical countries may have worm infestation.

Treatment. There is usually time to treat the patient with oral iron. It is essential to make sure that adequate doses of an active preparation are being swallowed. The ordinary doses may be doubled, e.g. ferrous

sulphate to 400 mg (6 gr.) three times daily, or ferrous gluconate to 600 mg. (10 gr.) three times daily, but nothing is gained by increasing the dose still further, as gastro-intestinal symptoms are then likely to develop.

Cases which do not respond, and in which full investigation has not shown any other type of anæmia nor any infection such as pyelonephritis, may be treated with parental iron. The same course may be followed if pregnancy is advanced and time is short, but if the patient is very near to term blood transfusion will be the only way to raise the hæmoglobin level quickly. In cases of very severe anæmia, such as may be seen in tropical countries, there is a risk of causing heart failure by overloading the circulation by transfusion, and either packed cells must be given slowly, or an 'exchange' transfusion.

Iron may be given parentally in two forms. Ferrivenin is a saccharated oxide of iron which is given intravenously. As dangerous reactions sometimes occur the first test dose is of only 1 ml.; subsequent doses of 5 ml. are injected slowly. Each 5 ml. is equivalent to 100 mg. of iron. Great care must be taken to avoid the irritant solution leaking outside the vein, and any injection should stop at once if there is severe local pain or any general reaction. Jectofer is a complex of iron and dextran which is injected intramuscularly, deep into the gluteal region.

Megaloblastic anæmia

For normal maturation of red cells in the bone marrow folic acid is required. If there is a deficiency of this substance the marrow becomes full of megoblasts, and the number of mature red cells in the circulation is reduced. The blood will contain macrocytic cells and occasional nucleated red cells (although the latter are rarely found in the blood in pregnancy).

Folic acid is essential for the synthesis of nucleic acid. During pregnancy, because of the increased fœtal demand combined with inadequate absorption from the diet, anæmia due to folic acid deficiency may occur in about 2 per cent of patients in this country, and the incidence is much higher in some tropical countries. It occurs most commonly in multigravidæ, in whom it may recur in successive pregnancies, and it is relatively more common in twin pregnancies.

The anæmia may develop rapidly in late pregnancy, and is often severe, with a hæmoglobin concentration of less than 9 g./100 ml. (60 per cent). In the past there have been a number of fatal cases. with also a high incidence of premature labour and fœtal loss. In severe untreated cases œdema, albuminuria and hypertension may occur, so that the diagnosis may be confused with that of pre-eclamptic toxæmia. The diagnosis should be considered in any case of severe anæmia during late pregnancy, and also in any case in which there is no response to the administration of adequate doses of iron.

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The excretion of foraminoglutamic acid (FIGLU) in the urine may be an index of folic acid deficiency. In the body histidine is normally broken down to FIGLU, but only in the presence of adequate amounts of folic acid. If there is a deficiency of folic acid an excess of FIGLU is excreted in the urine, and for the purpose of the test a loading dose of histidine may be given. This test is not a very accurate index of folic acid deficiency and many hæmatologists do not use it.

In severe cases marrow biopsy is justified, but in less severe cases with sufficient time before delivery the effect of giving folic acid may be tried without marrow puncture. Cases of megaloblastic anæmia in this country respond quickly to folic acid, 20 mg. daily by mouth.

Many obstetricians give folic acid prophylactically during pregnancy in doses of 5 mg. daily from the 20th week. It has been suggested that deficiency of this substance may also be related to some cases of abortion or of accidental hæmorrhage. The fear that the administration of folic acid will mask the diagnosis of Addisonian anæmia is unfounded, as this disease is not likely to be found in women of childbearing age, and because untreated anæmia of this type is usually associated with sterility.

Tropical megaloblastic anæmia

Megaloblastic anæmia is a common complication of pregnancy in some tropical countries. These cases also appear to be due to folic acid deficiency, but they are complicated by additional dietary deficiencies of protein or iron, or by blood destruction by malaria or sickle cell disease, or by blood loss due to hook worm infestation.

Sickle-cell disease

A few individuals, chiefly Negroes, have an abnormal hæmoglobin in their red cells. Cells containing a large proportion of this hæmoglobin become sickle shaped when anoxic (as for example when left under a sealed cover slip on a microscope slide), and such cells are easily hæmolyzed in the body. If the normal hæmoglobin is designated as A most normal individuals have the pattern AA. If the sickle factor S is inherited from only one parent the pattern is designated as SA and the patient is said to have *sickle-cell trait*. Such patients do not usually have any symptoms or trouble during pregnancy. If the abnormal factor is inherited from both parents the pattern is SS, and the patient is likely to have *sickle-cell anæmia*, with recurrent hæmolytic crises. In the crisis the patient has fever, abdominal pain and pain in her bones. The disease is progressive, and most patients die before the age of 30. Dangerous crises may occur during pregnancy or after any surgical operation.

Other abnormal hæmoglobins (e.g. hæmoglobin C) may be combined

with hæmoglobin S. In such cases the patients may be well except during pregnancy when there may be crises.

Although transfusion may be essential sometimes, it is not infrequently followed by dangerous reactions in these cases.

HEART DISEASE IN PREGNANCY

Although most patients with heart disease will go through pregnancy and labour successfully when their management has been conducted efficiently, the added risk they run is shown by the fact that heart disease still causes 11 per cent of all maternal deaths in England and Wales.

In order to understand why there is such a risk to patients who have more than a minor cardiac lesion, it would be appropriate brefly to review the physiological changes that take place during pregnancy.

The cardiac output rises progressively from the 12th to the 30th week of pregnancy to between 30 and 50 per cent above the non-pregnant level. The cardiac output remains at this level until about a month before term, after which it falls so that it is not far above the initial level at term. The increased blood flow is partly through peripheral capillaries, which show some dilatation, but is chiefly through the utero-placental 'shunt'. There must obviously be an additional flow of the same degree in the pulmonary circuit as in the general circulation. Less is known about the cardiac output during labour, but there is a large increase during the muscular effort of the second stage of labour. During the third stage the contraction of the uterus will squeeze a large volume of blood into the right side of the circulation. Even in the puerperium the cardiac output is still slightly above the non-pregnant level, and it is an unexplained clinical fact that cardiac failure not infrequently appears for the first time in the puerperium.

Ætiology of heart disease during pregnancy

By far the commonest cause of heart disease in pregnancy is *rheumatic carditis*. Although this disease is now becoming less common it still accounts for at least 85 per cent of cases. Mitral stenosis is the commonest lesion found, and there may also be mitral regurgitation or aortic regurgitation; aortic stenosis is rarely seen. Acute rheumatic carditis occasionally occurs during pregnancy, and if a patient has had a recent attack of acute carditis or of chorea this is often reactivated during pregnancy.

Congenital heart disease now accounts for over 10 per cent of cases. On the whole the patients who survive to the age of childbearing are those without cyanosis or gross disability, including cases of patent interatrial or interventricular septal defect, patent ductus arteriosus, aortic coarctation or pulmonary stenosis. Other cases of congenital heart disease are very rare in pregnancy.

Bacterial endocarditis may occur as a complication of rheumatic valvular disease or of congenital lesions, and as a rare result of streptococcal puerperal infection.

Cardiac failure is a rare complication of severe and relatively acute *hypertension* (e.g. during eclampsia), but is hardly ever seen in cases of chronic essential hypertension during pregnancy as this disease has seldom progressed to the stage of arteriosclerosis at the age at which pregnancy occurs. Coronary disease is almost unknown during pregnancy.

Puerperal cardiomyopathy. This term refers to rare cases of myocardial failure of unknown ætiology occurring in late pregnancy or the puerperium, and sometimes recurring in successive pregnancies. There is tachycardia, gallop rhythm and reversible cardiac dilatation, but the exact pathology is uncertain, and it is doubtful if it is a simple clinical entity.

PROGNOSIS

Although the lesions present in a particular case are obviously important, especially in cases of congenital heart disease, the functional capacity of the myocardium is the most significant factor in prognosis. Patients can be placed in four functional categories:

Class 1. No dyspnœa on ordinary activity even in pregnancy.

Class 2. (*a*) Slight dyspnœa with some limitation of ordinary activity.

(*b*) Moderate dypsnœa with considerable limitation of ordinary activity.

Class 3. Marked dyspnœa and restriction of ordinary activity but comfortable at rest.

Class 4. Dyspnœa even at rest—history of attacks of heart failure. The prognosis becomes worse with each succeeding class and the mortality during pregnancy has been given as: Classes I and II, 0·5 per cent; Class III, 2 per cent; Class IV, 15 per cent.

With gross cardiac enlargement or auricular fibrillation the risk is high because these are signs of myocardial damage.

Any evidence of pulmonary congestion is a serious sign, and respiratory infection will greatly increase the danger.

The availability of medical and obstetric care and the possibility of adequate antenatal rest are important factors in prognosis, and these depend not only on the social status of the patient but also on her willingness or otherwise to co-operate.

DIAGNOSIS

The diagnosis of cardiac disease during pregnancy is sometimes difficult. Dyspnœa of slight degree and œdema of the ankles may occur in normal pregnancy. The heart should always be examined carefully at the first antenatal visit. A soft systolic murmur without any other evidence of

cardiac disease may have no significance, but any diastolic murmur or a harsh systolic murmur always suggests organic disease. It is often difficult to determine the size of the heart during pregnancy, and in a doubtful case an X-ray examination should be made. Rotation of the axis of the heart occurs during pregnancy, which gives a false impression of enlargement, and also causes changes in the electrocardiograph.

Cyanosis, fibrillation or unequivocal evidence of pulmonary congestion, such as hæmoptysis or persistent moist rales, are always serious signs of organic disease.

MANAGEMENT

Good antenatal care will include:

(*a*) Adequate rest at home (10 to 12 hours at night and 2 hours horizontal rest in the afternoon) and provision of home-help and transport to and from hospital.

(*b*) Avoidance of respiratory infections—shunning people with obvious colds and crowded places of entertainment.

(*c*) The immediate treatment of respiratory infection.

(*d*) Avoidance and treatment of anæmia.

(*e*) Admission for prophylactic antenatal rest, sometimes for a fortnight or more at 28 to 30 weeks when the cardiac output is at its maximum, but always for 2 to 4 weeks immediately preceding delivery, depending on the cardiac class of the patient. The prophylactic rest need not be full rest in bed but rather a 'hotel existence' in hospital.

(*f*) Digitalis should not be used routinely, but only for cases with arrythemia or cardiac failure. Diuretics such as chlorothiazide may be of help if there is any œdema.

Such patients should never be booked for a confinement at home.

In early pregnancy a decision may need to be made when the patient is Class III or worse, whether valvulotomy is indicated or, if the lesion is unsuitable for operation, termination of the pregnancy. The answer to these problems will be reached after full discussion with the cardiologist. It is often implied that valvulotomy is a simple alternative to termination of pregnancy. This is hardly true. Few cases require termination, perhaps only those who have been in failure previously or those in which pulmonary back pressure is present and there is fear of pulmonary œdema. Valvulotomy is not best done as an emergency operation, and in any case it is only suitable for selected cases of uncomplicated mitral stenosis.

Cases of coarctation of the aorta run a slight risk of developing a dissecting aneurysm, but this risk will not justify Cæsarean section nor operation on the aorta during pregnancy.

Heart failure. Acute pulmonary œdema is most frequently seen in cases with tight constriction of the mitral valve; congestive failure is usually seen in cases with gross cardiac enlargement and often with fibrillation. The patient will be less distressed in a propped up position in bed. Reduction of œdema is brought about by restricting salt and fluid intake and by the use of diuretics. Digitalis is indicated in congestive heart failure, especially if there is fibrillation. In acute pulmonary œdema such measures as morphia and oxygen administration and venesection may be needed. Labour should never be induced while the heart is in failure except when the patient has improved as much as can be expected, and further deterioration is feared.

Mode of delivery. The aim should be an easy delivery and fortunately this usually happens. In the first stage sedative drugs should be used freely because tachycardia due to pain may be the starting point of failure. The second stage should be a short one, and if this is proving not to be the case then forceps delivery under pudendal block analgesia with, if necessary, the addition of skilfully given nitrous oxide and oxygen, avoids the harmful effects of prolonged expulsive efforts. If a general anæsthetic is required the services of an expert anæsthetist should be secured. Cyanosis is extremely dangerous and gas and air analgesia should never be permitted for these cases.

The indications for Cæsarean section are the same as for a patient with a normal heart, except that here any labour that is expected to be at all difficult shoud be avoided altogether. But when there is no obstetric reason Cæsarean section should not be done. It is a mistake to think that by avoiding labour the risk is less. The hæmodynamic changes following delivery seem to be more pronounced and their effects less well tolerated after Cæsarean section than after an uncomplicated vaginal delivery.

Postnatal care. Even after an easy vaginal delivery heart failure can appear quite suddenly. It may occur in mitral stenosis, but is seen relatively more commonly in aortic incompetence. The duration of rest in bed will depend on the severity of the cardiac lesion and how the patient has stood up to labour, but there should be no undue haste in getting any patient up who has a heart lesion. Adequate breathing and leg exercises in bed will achieve more in warding off the threat of embolism than early ambulation without the latter's added stress.

The patient will be encouraged to breast-feed her baby unless there is actual heart failure, but only if she intends to continue breast feeding after her return home.

If it has been decided, because of the severity of the heart lesion and its unsuitability for surgery, that the patient should have no further pregnancies, some authorities would advise abdominal sterilization during the

puerperium, after the patient has fully recovered from the delivery, that is 7 to 10 days later. It is an advantage too for her to have continued post-partum bed exercises.

Infective endocarditis may arise in the puerperium, and this should always be kept in mind if a patient with a cardiac lesion develops puerperal pyrexia and there is either no obvious cause or there is a poor response to antibiotics of standard dosage. Blood-cultures would help in making the diagnosis. Penicillin in large doses, possibly aided by other antibiotics, would be needed and treatment continued for several months.

LATE PROGNOSIS

The effects of chronic rheumatic valvular lesions tend to be slowly progressive. In mitral stenosis, the commonest lesion of all, the narrowing of the valve lumen gradually becomes more pronounced, causing inter-ference with emptying of the left atrium, pulmonary back pressure and eventually myocardial failure. The patient's age, social status, and type of cardiac lesion will obviously affect prognosis, and a general statement is not always easy, but is it not now believed that pregnancy causes any increase in the rate of progression of the disease. Progression may of course occur, but not to a greater extent than in women who have not been pregnant.

Cardiac surgery, not only in cases of mitral stenosis, but also in some congenital cases, may alter prognosis.

The heavy work and responsibility involved in the care of children may justify limitation of the size of the family, and suitable advice should be given at the postnatal examination. Sterilization may occasionally be required, but it is never justifiable to recommend Cæsarean section for delivery to permit this to be done.

PULMONARY TUBERCULOSIS AND PREGNANCY

The incidence of pulmonary tuberculosis during pregnancy is between 0·2 and 0·5 per cent in Britain, but some communities have a far higher incidence. An X-ray of the chest should be a routine examination during pregnancy (unless the patient has recently had this done); the radiation risk to the foetus is of no significance from a single chest X-ray. There is good evidence to show that generally speaking pregnancy does not adversely influence the course of this disease. Many clinical studies have shown that the proportion of patients whose disease progresses during or soon after pregnancy is no greater than would be expected in a comparable group of women who were not pregnant—provided that they are given full medical supervision. Termination of pregnancy is seldom required. The early case will usually respond to modern chemotherapy, and termination

will have little or no effect on the advanced case. Tuberculosis has little effect on the pregnancy. The fœtus is practically never infected *in utero*; the problem in the care of the child is the prevention of infection after delivery. In the majority of cases a good response in early active tuberculosis, whether in pregnancy or not, is largely dependent on the ability of the patient to take advantage of full medical management. Now that pulmonary tuberculosis is becoming increasingly controlled, there is no shortage of beds for tuberculous patients, and so there should be no difficulty in providing the care essential during pregnancy.

The important point is to know whether patient has active or quiescent disease, so that proper treatment can be given in pregnancy. Those with active disease will have full rest, preferably in a sanatorium, and antibiotic therapy. Anti-tuberculous treatment by means of streptomycin and sodium amino-salicylate (P.A.S.) or isoniazid has no adverse effect on the fœtus and may be used in pregnancy with confidence when indicated. Collapse therapy may be used and even the occasional major thoracic operation is not necessarily contra-indicated. Yet it is advisable, if possible, not to induce an artificial pneumothorax or to resort to thoracoscopy and division of adhesions within 6 weeks or so of term; major surgery too is usually better kept until after pregnancy.

Patients with quiescent disease should be radiographed every 3 months and again a month after delivery. Exacerbation of the disease may occur in the puerperium, but this is thought to be due to the added effort of looking after the baby rather than to increased excursion of the diaphragm. Therefore everything possible should be done to relieve this strain by further convalescence and help at home later. This is not to say that patients with active or recently quiescent disease should be encouraged to become pregnant. On the contrary, they should be instructed to avoid conception until their chest condition has been quiescent for at least 2 years. Those whose disease has only recently become quiescent may be given prophylactic chemotherapy for 3 months before and 3 months after delivery.

Management of labour. Patients with active or recently active disease should be delivered in hospital. Vaginal delivery is best, but this may be assisted with the forceps under pudendal block anæsthesia. Cæsarean section has no advantage unless there are other obstetrical indications for it.

Puerperium. Extra care will be needed after delivery. A few physicians still believe that there is a risk of re-activation of the disease in the puerperium, and it is undeniable that the care of a new baby may greatly increase the work a patient has to do. Continuity of treatment and supervision at the chest clinic is essential.

Breast feeding is forbidden for all mothers except those whose disease has been inactive for at least two years. In active, and especially open cases the danger of injecting the baby is very high and the child must be separated from the mother for a time.

The infant. All infants of tuberculous mothers should receive B.C.G. vaccination. If the mother has active disease the infant must be isolated from her until Mantoux conversion has occurred, usually after 8 weeks.

In some backward communities the incidence of tuberculosis is high and segregation is also impossible. Not only so, but artificial feeding may be associated with a high infant mortality rate. In these circumstances it is the practice to permit breast feeding, but to give the infant isoniazid and at the same time a vaccine prepared from isoniazid-resistant bacilli.

NON-PULMONARY TUBERCULOSIS IN PREGNANCY

In this country tuberculosis is now becoming less common and extra-pulmonary lesions are rarely encountered during pregnancy.

Genital tuberculosis. The commonest site for tuberculous infection in the female genital tract is the Fallopian tube and after that the endometrium. Infertility is the usual result, but in recent years a few patients have become pregnant after chemotherapy. Unfortunately tubal pregnancy has resulted in many of these cases, but a few normal pregnancies have occurred.

Bone and joint tuberculosis. Pregnancy itself has no adverse effect on the course of bone and joint tuberculosis, but problems may arise when active spinal disease needs immobilization. Not only would the increasing weight-gain throw a dangerously heavy strain on the weakened vertebral column, but any form of plaster jacket must allow for the ever enlarging uterus—so that termination is sometimes advised for active spinal disease. Similar problems may arise with active disease of the hip joint or sacro-iliac joint.

Healed tuberculosis, whether it be of the spine or the lower limbs may have resulted in a deformity and if this occurred during the growing years, the pelvis, being subjected to irregular stresses, may have developed unequally and finally become an asymmetrical pelvis. With sharp kyphosis of the lumbar region the sacrum tends to be rotated to compensate for this, so that its lower end is carried forward and the antero-posterior diameter of the pelvic outlet may be reduced.

Tuberculosis of the other joints usually present no special problems.

Renal tuberculosis. In a known case of renal tuberculosis the patient will be under supervision and full anti-tuberculous treatment. Termination of the pregnancy is usually advised, especially if there is extensive disease on both sides, or if one kidney has already been removed. A patient who has

been successfully treated for renal tuberculosis by chemotherapy or surgery would be advised not to become pregnant for at least two years.

When renal tuberculosis is seen for the first time in pregnancy, it may masquerade as pyelitis, but ordinary treatment fails or relapse occurs quickly. Whenever pyelitis fails to respond to adequate treatment or recurs, tuberculosis should be considered as a possible diagnosis. Sterile pyuria is not always found for there may be secondary infection from coliform organisms. The diagnosis would be made by a full bacteriological study of the urine including guinea-pig inoculation. Cystoscopy is difficult and intravenous pyelography undesirable during pregnancy, and these investigations may have to be postponed until after delivery.

RESPIRATORY DISEASES (OTHER THAN TUBERCULOSIS) DURING PREGNANCY

Pneumonia

Lobar pneumonia is a serious complication of pregnancy. During the acute illness abortion, intrauterine fœtal death or premature labour may occur. The disease follows the same course as in the non-pregnant and the same treatment is given, including antibiotics and oxygen.

Asthma

Most cases are unaffected by pregnancy, but cases of emotional origin may be worse if the pregnancy is resented, or better if it is welcomed. Cortisone should not be given during the first trimester unless it is absolutely essential, as there is a slight risk of its causing fœtal abnormality.

Emphysema and Bronchitis

During pregnancy the vital capacity is not reduced, but the respiration is more thoracic than abdominal, and patients with rigid rib cages may have severe dyspnœa. An antibiotic such as ampicillin 250 mg. twice daily by mouth may be given regularly during the winter months to prevent superadded infection. Assistance with forceps in the second stage of labour may be required.

Sarcoidosis

This disorder often appears to improve during pregnancy, but may relapse subsequently.

GLYCOSURIA IN PREGNANCY

The testing of urine for sugar at the beginning of pregnancy and at intervals throughout is an important part of antenatal care. In this way unsuspected diabetes will not infrequently be discovered and will then be brought under treatment to the great benefit of both patient and fœtus.

There is no doubt that pregnancy will occasionally cause diabetes to appear in a patient who earlier in pregnancy was found to have no glyco- suria. It is for this reason that the urine should be tested for sugar, not only at the beginning of pregnancy, but at least monthly, and if it is found, further investigation made to find out its significance.

Sugar found in the urine in pregnancy may arise from one of the follow- ing conditions:

1. Lowered renal threshold.
2. Diabetes mellitus.
3. Lactosuria.

The modern way of testing urine for sugar is by the small *Clinitest* method which is a convenient modification of Benedict's test. If this is positive *Clinistix* papers are used to find out if the sugar is glucose. The *Clinistix* papers are impregnated with a mixture of glucose oxidase and peroxidase and ortho-tolidine. If glucose is present it reacts with glucose oxidase to form gluconic acid and hydrogen peroxide. The latter acting on ortho-tolidine gives a blue colour in the presence of peroxidase. If it is not glucose the possibility of its being lactose arises. Whenever sugar is found in the urine the specimen should also be tested for acetone bodies.

Lactosuria

This is only very rarely found during pregnancy near term, but may occur during lactation. The *clinistix* paper will give a negative reaction and if final proof of the type of sugar is required, the osazone test would reveal it. It is of no consequence.

If the reducing substance in the urine is shown to be glucose then the blood sugar concentration should be estimated when the patient is fasting. She is then given 50 G. of glucose by mouth, and the blood sugar esti- mated again after 1 and 2 hours. The urine is tested for sugar at the time of each of these estimations.

The normal fasting blood-sugar level is less than 100 mg./100 ml., and the one and two hour levels are less than 180 and 120 mg/100 ml. respect- ively. Sugar does not normally appear in the urine when the blood sugar level is less than 180 mg./100 ml. (the renal threshold). If the patient is a diabetic the blood-sugar will rise above the levels indicated and will not return to normal during the two hours.

If there is doubt about the blood-sugar curve the observations may be repeated after the administration of cortisone, but the value of this in pregnancy, when there is normally an increased output of cortisone, is questionable.

Lowered renal threshold

Proof that this is the reason for glucose being present in the urine is

shown by the sugar tolerance test—sugar appearing in the urine when the blood-sugar is well below the normal renal threshold level (180 mg. per 100 ml.). Lowering of the renal sugar threshold occurs quite commonly in pregnancy and is thought to be due to increased blood flow through the glomeruli, so that such a large amount of sugar enters the glomerular filtrate that the tubules cannot reabsorb it adequately during the time the fluid is passing through. It is only a temporary state, and function returns to normal after the pregnancy. Being a common condition in pregnancy, it will sometimes accompany diabetes mellitus, and the elucidation can be brought about only by the sugar tolerance test. A lowered renal threshold for sugar can make the management of true diabetes more difficult, not only because ordinary urine tests are confused, but also because of the loss of sugar in the urine.

Diabetes mellitus

Before 1923 when insulin was isolated and became available for treating diabetes mellitus, diabetic patients seldom become pregnant because of the severity of the disease, unchecked by treatment, often caused amenorrhœa. In those days this was fortunate because pregnancy enormously increased the risk they ran. Not only did the patient herself stand a 30 per cent chance of dying, but the fœtus stood a far greater one, 40 to 50 per cent, even in those patients who themselves survived.

Since the introduction of insulin there has been a spectacular reduction in the maternal risk, to 0·5 per cent, but the fœtal mortality has shown a disappointing persistence at about 10 to 15 per cent. This fœtal loss is now the chief problem of diabetes in pregnancy.

Pre-diabetic phase. Recently attention has been drawn to the significant obstetric histories of women during the years preceding the onset of established diabetes mellitus. Some of these patients give a family history of diabetes. The history will often be one of either unexplained intra-uterine fœtal deaths or the birth of abnormally large babies which may not have survived. Although the blood-sugar level of such patients need not be abnormal, nor the ordinary sugar tolerance curve diabetic in type, their babies at autopsy often show the hypertrophic changes in the pancreas, characteristic of the babies born of true diabetics. It is suggested that this syndrome is due to excessive secretion of growth hormone from the anterior pituitary gland.

Effect of pregnancy on diabetes

During pregnancy most diabetics require more insulin to maintain control, and ketosis is sometimes less easily prevented, especially in cases with a low renal threshold in which large amounts of sugar are being lost in the urine. In a few exceptional cases the insulin requirement falls.

Effect of diabetes on pregnancy and on the fœtus

The chief problem is that of fœtal death. If the pregnancy is allowed to continue to term the fœtus not infrequently dies *in utero* during the last three weeks of pregnancy, and the risk is greatly increased in cases in which the diabetes is inadequately controlled. There is also a slightly increased risk of fœtal malformations. The fœtus is often very large, weighing as much as 10 pounds at the 37th week. The placenta is large, and there is often hydramnios. The large size of the child increases the risk of vaginal delivery.

Because of the risk of intrauterine death many of these babies are delivered by Cæsarean section or induction of labour before term, but even if they are delivered alive there is still a considerable risk of death in the first 48 hours from atelectasis due to hyaline membrane formation in the lungs (see p. 638) and consequent respiratory and metabolic acidosis.

Pre-eclamptic toxæmia is more common in diabetics than in other patients. A few severe diabetics have vascular disease with retinitis, hypertension and albuminuria (diabetic glomerulo-sclerosis) and in these patients the prognosis is very bad, especially for the fœtus.

Management. The care of a patient suffering from diabetes mellitus who becomes pregnant should be undertaken by both diabetic and obstetric units. The object is to keep the diabetes as well controlled as it is possible to do, and to deliver the fœtus before it dies *in utero*. In order to make sure that wide fluctuations in the blood-sugar level do not take place, it is often advisable to have the blood-sugar estimated frequently throughout one day on several occasions from mid-pregnancy onwards. This would be especially indicated if glycosuria became increased or ketonuria appeared. Although it is known that very commonly pregnancy temporarily aggravates the diabetes, increasing the insulin requirement, the problem is often complicated by a lowering of the renal threshold for sugar. Near mid-pregnancy the insulin should be changed to the soluble kind, partly so that the more frequent injections of the soluble insulin will meet the needs more uniformly, and partly so that the sudden diminution in the insulin requirements after delivery can be met quickly. For this change-over, the patient is admitted to hospital for a few days—for 'stabilization' (re-adjustment of dietetic and insulin requirements). The obstetric care of the diabetic calls for a close watch for the complications which are known to be more common in diabetes and for a decision on the time and form of delivery.

Evidence is growing that the outlook for the fœtus is greatly improved by admitting diabetics to hospital for a month or so before delivery for antenatal rest and closer control of their diabetes. It is hardly necessary to say that because of the need for specialized care of both mother and baby,

even the most mild diabetics should be delivered in a hospital suitably equipped for Cæsarean section and for the care of the premature infant, and with laboratory facilities.

Diabetic vulvitis. The patient may complain of soreness and irritation of the vulva before it is known she has diabetes. Diabetic vulvitis has a characteristically florid appearance; the whole vulva is blotchy pinkish red and swollen with the rash fading upwards to the mons veneris and outward to the thighs. It is due to monilial infection and it is always associated with monilial vaginitis. The diagnosis is confirmed by finding the mycelia of the fungus on microscopical examination.

It is treated by controlling the diabetes and by the use of nystatin vaginal pessaries and vulval cream. The curdy white debris is first removed from the vagina by gentle swabbing with a sodium bicarbonate solution before the pessary treatment is begun.

Time and mode of delivery. When pregnancy is otherwise uncomplicated delivery at about the 36th week is favoured by the majority of obstetricians, although some choose a week later. In the presence of toxæmia, definite hydramnios, evidence that the fœtus is abnormally large or history of previous intrauterine death before the 36th week delivery would have to be considered earlier, especially if control of the diabetes was proving difficult, bearing in mind the dangers which increasing prematurity carries, and the need for excluding gross fœtal abnormality by X-rays if palpation is difficult.

As well as being safer for the the fœtus, Cæsarean section, being a planned operation, is a better-managed form of delivery for the mother who can be given a calculated amount of glucose to cover the requisite dose of insulin for a known degree of diabetes. The delivery too can usually be planned to coincide with the ready attendance of pædiatric and laboratory personnel if need be. The same cannot be said for labour with all its uncertainty. However, certain multiparæ may well be treated by induction of labour, Cæsarean section being done when labour does not follow the induction.

Pre-operative glucose should never be given into the stomach, but should be given intravenously, because aspiration into the lungs from regurgitation during anæsthesia can cause fatal pulmonary œdema.

The demand for insulin falls off soon after delivery and frequent blood-sugar estimations will be needed until the level again becomes stable.

The infant. It is a wise precaution to keep the infant, large as it often is, in an incubator for the first 48 hours because of the liability to attacks of cyanosis and to hyaline membrane disease. Oxygen is then ready to hand, the humidity can be kept at about 80 per cent and the temperature at 90°F.

The babies of diabetic mothers are œdematous and lose weight rapidly,

but because of the increased tissue fluid they do not need to be given fluids (or food) for the first 2 days. There is no tendency to hypoglycæmia.

Finally the babies, in spite of their size, are premature, and need to be treated with gentleness. They, like their mothers, are also prone to infection.

ACUTE SPECIFIC FEVERS

Although pregnancy does not alter the course of most acute specific fevers the fœtal results may be serious. With high fever and toxic effects either miscarriage or premature labour may occur. Some organisms reach the fœtus, including those of rubella, smallpox, vaccinia, chickenpox, typhoid fever, Coxsackie virus disease, cytomegalic inclusion disease and toxoplasmosis.

Rubella. The significance of the association of rubella in the mother during pregnancy and congenital defects in the infant was first brought to notice in 1941 by Gregg and since then many other series of cases have been published.

The incidence of abnormalities seems to vary from country to country and also with each epidemic, the highest being reported from Australia.

The virus produces different effects on the fœtus at different stages of pregnancy. Infection during the 1st and 2nd months may cause congenital cataract or cardiac valvular defects; during the 3rd month deafness may result. Once the 4th month is reached the virus appears to cause no harm to the fœtus. The incidence of damage may be 50 per cent with infection in the 1st month, 30 per cent in the 2nd month, and 15 per cent in the third.

In the prevention of infection during pregnancy it is important that pregnant women should avoid contact with any known case of rubella. If a patient has already had the disease there will probably be some immunity but reliance cannot be placed on this. Therefore, if a pregnant woman in the first 4 months of pregnancy has been in contact with rubella, a temporary passive immunity should be aimed at by giving an intramuscular injection of 750 mg. of gamma-globulin immediately. This may offer some, though not complete, protection against acquiring the disease; but if the mother already has rubella it will not protect the fœtus.

If rubella is contracted in the early months of pregnancy what is to be done? The law at present in this country would not allow therapeutic abortion on the grounds of risk to the fœtus, although many cases have now been terminated because of the mental distress of women who have knowledge of the possibility of fœtal abnormality.

Measles. Measles is reported to have affected the fœtus *in utero*, but has not been proved to cause fœtal abnormalities.

Typhoid fever. Typhoid fever is a serious complication of pregnancy in that abortion, stillbirth or premature labour occurs in a very large proportion of the cases; but the pregnancy does not effect the disease. The bacilli have been demonstrated within the organs of the fœtus, and ulceration of Peyer's patches may also be found in the fœtal intestine. The stillbirth rate is high.

Small-pox. The prognosis of small-pox during pregnancy is more serious than in the non-pregnant state, the confluent and hæmorrhagic varieties being commoner. Abortion, stillbirth or premature labour may occur and children have been born with the eruption. Vaccination during the first trimester of pregnancy is not without risk to the fœtus, and should not be carried out at that time unless the mother has been in contact with a case of small-pox.

Chicken-pox. Varicella runs a similar course in pregnant and non-pregnant women. There is no increased liability to premature labour. The child may be born covered with the rash. There is no proof that this infection causes congenital abnormalities.

Scarlet fever. This disease is due to the hæmolytic streptococcus which may also cause puerperal fever, and a scarlatiniform rash can occur in cases of puerperal streptococcal infection. If the fever occurs during pregnancy the disease is more serious, especially if it arises towards the end of pregnancy. Abortion is likely to follow during the early months. There is no evidence that the fœtus may be born with the disease, nor that it causes congenital defects.

Poliomyelitis. Susceptibility to this disease may be increased during pregnancy, although the point is disputed. During the initial pyrexial illness or during severe hypoxia fœtal death may occur, but the virus does not cause fœtal abnormalities, and paralysis of the newborn infant is an exceedingly rare event. During labour special care is only required if respiration is impeded, and then forceps delivery might be better than Cæsarean section. Immunization against poliomyelitis can safely be carried out during pregnancy.

Chorea. So-called chorea gravidarum is only Sydenham's (rheumatic) chorea occurring during pregnancy. If a patient who has recently had chorea becomes pregnant a recurrence of the symptoms is common. In

recent experience of the disease recovery has been the rule and termination of pregnancy is not required.

Malaria. During pregnancy severe exacerbation of latent malaria occurs and disease which is already active is made worse. Abortion or premature labour frequently occur, especially in cases of malignant tertian infection. The parasite does not cross the placenta and the newborn infant is not infected.

The suppressive drug pyrimethamine (Daraprim) 25 mg. weekly should be given to all pregnant women in malarious areas. If infection occurs the same treatment is given as in the non-pregnant, including mepacrine, quinine and proguanil.

Influenza. During the recent epidemic of Asian influenza it was shown that the incidence of abortion and of premature labour was increased among pregnant patients, and with infection in early pregnancy the incidence of fœtal abnormalities also appeared to be increased.

Toxoplasmosis. This is a rare disease due to a small protozoon. The mother may only have a transient febrile illness, but the disease is transmitted to the fœtus, in which it causes encephalomyelitis and choroidoretinitis. Most infants die, but those that survive for a time may have blindness, mental defects, hydrocephalus and calcification in the cerebal lesions. Diagnosis is difficult and seldom made during pregnancy; it is usually only evident when the child is born. Fortunately one attack gives immunity, and the children of subsequent pregnancies are normal.

DISEASES OF THE ALIMENTARY TRACT

Dental caries. Decayed teeth and gingivitis are often observed during pregnancy or after delivery. The popular saying is 'For every child a tooth', and the popular belief is that the caries is due to calcium deficiency. Since the intact enamel is not vascularized decalcification is hardly possible, but if the dentine has already been exposed then decay may progress more rapidly. Dental inspection and treatment should be carried on in pregnancy. Fillings or extractions should be performed with local anæsthesia if possible, and if a general anæsthetic is required 'gas' in a dental chair is most unwise during pregnancy. A proper anæsthetic with every precaution taken against anoxia should be given.

Ptyalism is excessive salivation. In some cases there seems to be an excessive secretion of saliva during pregnancy, but in others the patient is merely spitting out all her saliva instead of swallowing it. She sits all day

spitting into wet handkerchiefs or even a bowl. As much as 2 litres of fluid can be lost in a day. The symptom is probably of psychological origin, but any local abnormality such as gingivitis or any abnormal diet should be corrected. Ointments may be required for soreness of the wet skin, and tranquillizers and psychological treatment may help.

Heartburn. During pregnancy the cardiac sphincter is relaxed and acid regurgitation may occur. Sometimes troublesome heartburn is due to a hiatus hernia. Relief may be obtained with alkalis, e.g. aluminium hydroxide tablets, or by sucking tablets of dried milk and alkali (Nulacin).

Peptic ulcer. Symptoms usually improve during pregnancy.

Appendicitis. The combination of appendicitis and pregnancy is not frequent. It is found most commonly in the first 6 months, and is comparatively rare after that time. The danger of appendicitis during pregnancy and the puerperium is enhanced because it is more difficult to diagnose early and to drain the pelvis efficiently after operation. Miscarriage is also likely to occur.

Diagnosis. Abdominal pain on the right side may be due to pyelonephritis, extra-uterine gestation, hæmorrhage into the corpus luteum, torsion of an ovarian cyst, red degeneration of a fibroid, biliary or renal colic, or appendicitis; while in addition pain not so localized may be associated with the uterine contractions due to labour or miscarriage; a small right sided retroplacental hæmatoma may also simulate appendicitis. The most frequent error is to confuse pyelonephritis with appendicitis; in every case, therefore, the urine should be carefully examined.

Although the vomiting associated with appendicitis has been mistaken for hyperemesis gravidarum, its sudden onset and the condition of the pulse, temperature, and urine should make the diagnosis clear. Appendicitis during the early days of the puerperium has on occasions been confused with puerperal sepsis.

The usual physical signs are somewhat altered when appendicitis complicates pregnancy. The cæcum, if freely movable, is pushed upwards and outwards by the enlarging uterus. The area of tenderness is at a higher level than usual and there may be little rigidity of the abdominal wall.

Treatment. If an operation is advisable, it should be performed in spite of the pregnancy. An adequate right paramedian incision should be made and the appendix sought well above the level of the iliac crest, but in late pregnancy a transverse muscle cutting incision (Rutherford Morison) over the site of the tenderness may be better. It is usually advisable to give antibiotic cover; morphia too will be needed in sufficient amounts to prevent the onset of labour. In a woman who has already had an attack, and

is likely to become pregnant, appendicectomy is indicated as a prophylactic measure.

Intestinal obstruction. The commonest cause of intestinal obstruction during pregnancy is a band resulting from adhesions following a previous operation. The obstruction usually results from altered positions of the viscera brought about by the enlarging uterus. Other causes of obstruction are strangulated internal or external hernia, volvulus, intussusception and mesenteric thrombosis.

One of the great dangers of intestinal obstruction in pregnancy is the delay that often elapses before the correct diagnosis is made, the symptoms so often being attributed to the pregnancy. The classical symptoms, pain, vomiting and constipation, will be present, but the physical signs of tenderness and distension may be masked by the bulk of the enlarged uterus. A scar on the abdomen of a patient whose chief symptom is vomiting should always suggest the possibility of intestinal obstruction. Pyelonephritis, appendicitis, hyperemesis gravidarum, ureteric calculus and torsion of the pedicle of an ovarian tumour would all need to be considered in making the diagnosis. When the diagnosis has been made, laparotomy should be done with minimal delay. Salt and fluid replacement intravenously as a preliminary to operation could be the only reason for a temporary postponement. Needless to say a stomach tube would be passed in any case before operation for the twofold purpose of making anæsthesia safer and the operation less difficult. Laparotomy for the relief of obstruction, even without pregnancy, can be a very tedious operation; therefore, if the bulk of the uterus is such as seriously to interfere, it will have to be emptied by lower segment Cæsarean section before the obstruction is relieved.

Ulcerative colitis. This disease is sometimes worse during pregnancy, and in that case adrenal steroids may be given orally or by retention enemata. A patient who has had ulcerative colitis would be wise to avoid pregnancy until the disease has been quiescent for 2 years.

Acute pancreatitis in pregnancy. Acute pancreatitis presents no unusual features because of pregnancy; nor is it common in pregnancy, there being only about fifty reported cases, the vast majority of which occurred in the puerperium. Gall bladder disease is a frequent accompanying finding and may be the cause.

The correct diagnosis is seldom made during pregnancy. The most common symptoms are epigastric pain and vomiting. The pain may radiate to the back and to the shoulder.

The physical signs are variable too, but usually the patient is ill with slight pyrexia and dusky cyanosis of the face and neck. The abdomen is tender but there is often no rigidity.

The serum amylase and the urinary diastase index may be raised. Usually the diagnosis is made at laparotomy by finding brownish coloured free fluid and fat necroses in the omentum. If the diagnosis can be made with certainty, which is unusual, laparotomy should be avoided and the patient treated with sedatives, attention to hydration and electrolytes and with antibiotics to prevent secondary infection. If the diagnosis is made at laparotomy the abdomen should be closed without drainage unless suppurative peritonitis already exists.

JAUNDICE AND HEPATIC NECROSIS DURING PREGNANCY

Acute hepatic necrosis, infective hepatitis and homologous serum jaundice

Infective hepatitis, due to infection with a specific virus, is a febrile condition with a well recognized course, and when it occurs in an epidemic is easily diagnosed. The jaundice is marked and vomiting not usually severe. The liver is generally palpably enlarged. The patient does not as a rule become gravely ill and recovery is the rule in Britain. Hepatic necrosis is a rare sequel which has been reported to occur more frequently in such cases in Africa, and preceding nutritional deficiencies may increase the risk of necrosis. The hepatic lesion is one of centrilobular necrosis. If severe liver failure occurs there is deepening jaundice, severe vomiting, epigastric pain, headache, restlessness, delirium and convulsions, followed by increasing coma and death.

Infective hepatitis may also occur as the result of infection with another type of virus in a blood or plasma transfusion or during the use of a contaminated syringe. It is then referred to as homologous serum jaundice.

Toxic hepatitis due to chemical agents

Delayed chloroform poisoning may cause death from liver failure a few days after prolonged or repeated administration of chloroform during pregnancy or labour. Necrosis of liver cells is always found post-mortem and it varies in its lobular distribution according to the circumstances in which the chloroform was given. An overdose of chloroform in a healthy patient gives rise to an isolated cell necrosis; chloroform given to an exhausted patient, e.g. after a prolonged labour, is followed by mid-zone necrosis; chloroform given to a patient suffering from hyperemesis gravidarum produces central necrosis.

Other substances such as cinchophen, chlorpromazine compounds, bromethol, trichlorethylene and fluothane may occasionally cause hepatic necrosis.

Eclampsia. Hepatic lesions of a specific type may occur. (See p. 192.)

Obstetric yellow atrophy (Acute fatty metamorphosis)

Sheehan has described rare cases of acute liver failure which occurred in late pregnancy without evident cause. Postmortem examination showed fatty infiltration of the liver cells without necrosis. A few patients have recovered, sometimes after receiving cortisone. The kidney cells may also be involved. These do not seem to be cases of viral hepatitis.

Hyperemesis gravidarum

Very rarely jaundice and death may occur. In such cases the liver shows gross fatty infiltration, but there is no nĕcrosis of cells.

Other causes of jaundice

All the causes of jaundice in non-pregnant women may occur in pregnancy and give rise to difficulty in diagnosis. An example is cholelithiasis.

Treatment. The treatment of liver failure in pregnancy is conservative. Glucose is given orally and a 5 per cent solution may also be given intravenously. To this 10 ml. of a 10 per cent solution of calcium gluconate may be addęd daily. No benefit has been shown to occur from injections of insulin or methionine, although they have often been used. Termination of the pregnancy is unlikely to be helpful in arresting hepatic necrosis.

VENEREAL DISEASES IN PREGNANCY

Gonorrhœa. The disease may be contracted before, or during pregnancy, or at the time of conception. The presence of uncomplicated gonorrhœa does not appear to diminish the chance of conception, but gonococcal infection of both Fallopian tubes is likely to result in sterility.

The symptoms and signs of gonococcal infection are not modified by pregnancy. The point which requires emphasis is that at least 30 per cent of women suffering from gonorrhœa have such slight symptoms that they do not complain of them. When vaginal discharge is present it may well be due to associated trichomonal or monilial vaginitis, both of which are apt to be more severe and persistent in pregnant than in non-pregnant women.

The disease is unlikely to affect the pregnancy although in a few cases the disease has spread to the uterine cavity and Fallopian tubes after delivery. During labour the child's eyes are in danger of being infected and this may be the first reason for suspecting the presence of the infection. Because of this a full investigation of any vaginal discharge during pregnancy is indicated. Both microscopic smears and cultures are essential and they should be taken directly from both urethra and cervix with the aid of a

speculum on at least two occasions. No reliance should be placed on the so-called 'high vaginal swab' procedure. The complement fixation test for gonorrhœa has only limited value in the diagnosis of this disease as it is not positive in the acute stage and it is only positive in a proportion of cases of long standing.

Treatment. The treatment of acute gonorrhœa during pregnancy does not differ from that which would be given to non-pregnant women.

Penicillin is the drug of choice and a single intramuscular injection of 600,000 units of procaine penicillin suffices for most cases. There is, however, evidence that strains of gonococci partially resistant to penicillin are becoming more common. After treatment smears and cultures should be repeated for 3 weeks. If the gonococcus is still present or reappears the remedy should be changed. Streptomycin may be given in doses of 1 G. intramuscularly daily for 2 to 5 days. Tetracyclines by mouth are also effective but are seldom required. Douching is unnecessary, and indeed contra-indicated, but local treatment may be indicated for the control of associated conditions such as trichomonal vaginitis or moniliasis. A Bartholin's abscess may be treated by incision. Any surgical procedure should be accompanied by systemic treatment with appropriate antibiotics.

If gonorrhœa is first diagnosed when the patient is in labour, one million units of crystalline penicillin should be given. During the early stages of the puerperium, the penicillin should be continued but in reduced dosage.

Sometimes gonorrhœa and syphilis are contracted simultaneously, and it is a disadvantage of treatment with penicillin that the signs of early syphilis may be suppressed, although the disease may not be cured. If syphilis is suspected, streptomycin should be used in preference to penicillin. Serological tests for syphilis should be performed at the end of the observation period for gonorrhœa, and regularly during this period if syphilitic infection is a considerable possibility.

Treatment of the child's eyes. In this country time honoured preventive treatment with 1 per cent silver nitrate solution instilled into each conjunctival sac is no longer popular because of the chemical conjunctivitis it causes, and since antibiotic treatment is now very effective it is considered justifiable to omit routine prophylactic treatment. However, in a case of known gonococcal infection of the mother prophylactic treatment with either silver nitrate or penicillin should be given. In any case of ophthalmia neonatorum the pus should immediately be examined bacteriologically. Without waiting for the result, treatment with penicillin should be started at once. Locally, crystalline penicillin, 10,000 units per ml. is instilled every minute until pus ceases to form, which may take 30 minutes or more. Thereafter instillations are continued at lengthening intervals. Penicillin may also be given by intramuscular injection. A single dose of 200,000 units of crystalline penicillin should be adequate.

Syphilis. Syphilis is an important cause of the premature interruption of pregnancy but, owing to the fall in incidence of syphilis, it is an uncommon factor in this country at the present time. During the active stage of syphilis the *Treponema pallidum* invades the placenta from the maternal blood stream. The organism causes inflammation with endarteritis, and soon invades the fœtal blood stream. When it is suspected the fœtal tissues should be examined for the presence of *Treponema pallidum* and both parents should be investigated, clinically and serologically. A woman who becomes infected during pregnancy or who becomes pregnant during the early stages of the disease, may show few or no signs. A woman who has given birth to a syphilitic child is herself syphilitic.

The effect of untreated syphilis upon pregnancy varies according to the lapse of time between infection and pregnancy and the treatment, if any, during pregnancy. Full treatment by modern methods will almost certainly protect the fœtus, or perhaps cure it if is already infected. The importance of the lapse of time is variable, but if the mother has syphilis during the pregnancy, the child is almost certain to contract it too. If 5 or more years have elapsed between infection and pregnancy, the child is unlikely to be affected, even though the mother receives no treatment. Syphilitic infection of the fœtus may result in abortion at any time from the 4th month of pregnancy onwards. There is some evidence that premature birth is a little more common among syphilitic than non-syphilitic babies. The double hazard of syphilis and prematurity is likely to cause the death of the child. Syphilitic babies born at term may have gross signs of infection or may appear to be normal. The more recent the infection in the mother the more likely is the disease to be manifest at birth. If the child is apparently healthy, it is very likely to develop some evidence of syphilis during the first year of life, but the evidence may be slight and it may be missed. The early signs include rashes of the skin, lesions of mucous membranes, enlargement of liver and spleen, and snuffles. The child with severe infection often wastes rapidly and is likely to be severely ill.

Serological tests for syphilis should be performed as a routine in the antenatal clinic. The results of these tests should not be regarded as absolute proof of infection, and a positive serological test for syphilis in a patient without history or signs of the disease requires further investigation by another serological test and by the treponemal immobilization test.

Treatment. Treatment should be adequate and should not be delayed. Penicillin is the drug of choice, and a low continuous level of the drug in the blood is more effective than a high concentration which is intermittent. Repository preparations which are absorbed from a deposit in the tissues are excellent for this purpose. Procaine penicillin is the standard remedy and it may be given in watery suspension, or in oily suspension to which is added 2 per cent of aluminium monostearate. Either should be injected

in doses of 600,000 units intramuscularly daily for 10 days and this is usually sufficient. Arsenicals and bismuth add no additional benefit in these cases and the former are dangerous. After treatment the mother should be observed and tested periodically. If she remains well clinically and the blood-tests do not become more strongly positive, no further treatment need be given. Clinical or serological relapse necessitates repetition of the treatment but the fact that blood-tests do not at once become negative does not. After delivery the mother should remain under skilled observation and in due course her cerebrospinal fluid should be tested. It is common practice to repeat the course of treatment in subsequent pregnancies unless there is some contra-indication.

The fact that the cord blood, or the venous blood of an infant born of a syphilitic mother, shows negative serological tests for syphilis does not exclude infection. Furthermore, if the mother's serological tests are still positive, positive tests of the cord blood or venous blood do not necessarily mean that the infant has syphilis. In such a case, in the absence of clinical and radiological signs of syphilis, treatment should be withheld, and if the infant is not suffering from syphilis serological tests will become negative in about 8 weeks.

If the infant is proved to be suffering from syphilis, there should be no further delay in treatment. Penicillin gives excellent results and other remedies are usually unnecessary. Dosage may be based on body-weight, and a good plan is to give 450,000 units per kilogram (200,000 units per pound) and to space the administration over 8 to 10 days. Injections may be given intramuscularly every 3 hours day and night, but missing one dose at night. Thus, for a child weighing 3·2 kg. (7 pounds) the total dosage would be 1·4 mega units and, assuming 10 days of treatment, the daily dosage 140,000 units and the individual dose 20,000 units. Alternatively, 150,000 units of procaine penicillin can be given intramuscularly each day for 10 days. Subsequent observation and tests should continue for many years, or at least until growth ceases. For full details of the management of these problems textbooks on venereology should be consulted.

NEUROLOGICAL DISEASES IN PREGNANCY

Epilepsy. Epilepsy has no significant effect on pregnancy, even in those patients in whom the fits are difficult to control. There is no tendency to abortion or premature labour. The effect of pregnancy on the epilepsy is extremely variable, and there is just as good a chance of the disease being improved as there is for it to be unaffected or made temporarily worse. Exacerbation may occur in cases with generalized œdema or pre-eclamptic toxæmia. This fits in with the observation that epilepsy is often worse at menstruation, suggesting that fluid retention, due to an elevated œstrogen level, may well be the trigger mechanism in both cases.

In the management of epilepsy in pregnancy, therefore, an important point is played by restriction of sodium and fluid intake and keeping an even closer watch for the onset of toxæmia; regular weighing would make a useful contribution. The patient should continue with her usual anticonvulsant drugs.

The chance of the progeny being affected when one parent has epilepsy has been rated as 1 in 10, and it is not uncommonly the first born, though 60 per cent of the other children unaffected by the disease will have inherited the *tendency* to epilepsy.

Disseminated sclerosis. Opinions differ as to whether or not pregnancy adversely affects the course of this disease. The majority view at the present day is that pregnancy has no effect and that any changes which occur in pregnancy would have taken place in any case. Discussion of the risks involved is often made difficult by the fact that in many instances the true diagnosis has not been disclosed to the patient and it is usually left to the husband to decide whether or not pregnancy should be embarked upon. If there is no interference with locomotion or with natural functions, special treatment during pregnancy is not necessary. Spinal and caudal analgesia should be avoided at delivery.

Subarachnoid hæmorrhage. Rupture of an intracranial aneurysm may occur during pregnancy, or a patient may become pregnant who has previously had this accident. Unless the hæmorrhage occurred within ten weeks of delivery, assisted vaginal delivery is preferable to Cæsarean section.

Cerebral thrombophlebitis. Thrombosis of cerebral veins or dural sinuses may occur during pregnancy or the puerperium. A few cases are associated with pelvic infection, but often the cause is obscure. There may be general signs such as headache, fits and coma, often with fever and vomiting, or there may be focal neurological signs such as hemiplegia or aphasia. Anticoagulant drugs are given. Recovery is to be expected.

Acroparæsthesia (Carpal tunnel syndrome). Many pregnant women complain of tingling and numbness in the hands. The discomfort is often bilateral, and it may sometimes extend up the arm, but it is often confined to part of the hand. It is generally stated that these cases are all due to compression of the median nerve by œdema in the carpal tunnel, but it must be said that the distribution of the paræsthesia in the hand does not always support this idea. Some, but not all, cases are relieved by giving diuretics such as chlorothiazide. Recovery after delivery is the rule.

Cramp in pregnancy. Nocturnal cramp (painful muscular spasm) is noticed by many pregnant women. The cramp occurs most frequently in the

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calf muscles or the small muscles of the feet, and may be bilateral. Although treatment with calcium gluconate is often given, on the basis of the theory that the cramp is muscle tetany due to a calcium deficiency during pregnancy, there is no satisfactory evidence to support this. The cramp tends to improve in late pregnancy.

ENDOCRINE DISORDERS IN PREGNANCY

Addison's disease. Addison's disease only very rarely complicates pregnancy; approximately 100 cases have been reported in the literature.

It presents much the same features in pregnancy as in the non-pregnant state. Typical Addisonian crises may occur at any time, but are commonest during early pregnancy when vomiting may accentuate any electrolytic disturbance, during the stress of labour, or during the early puerperium.

Since the introduction of cortisone the mortality in pregnancy has been reduced from 35 per cent in the years before 1930 to less than 5 per cent at the present day. During labour and immediately afterwards the dose of cortisone needs to be raised considerably. Because of the fluctuating needs of adrenal replacement-therapy both in pregnancy, and more especially in labour and early puerperium, it is important not only that regular clinical assessment is made, but also that biochemical blood-assays are frequently carried out especially as regards sodium, potassium and sugar levels.

Lactation used almost invariably to fail before cortisone became available but its advisability is still doubtful.

The infant. There is a high neonatal death rate, the cause being uncertain. 17-ketosteroid excretion seems to be normal, but as gastro-intestinal upsets occur it is possible that there is relative suprarenal deficiency, especially as the adrenals commonly show cortical thinning.

Acute adreno-cortical insufficiency. This dramatic complication may affect patients who are known to have depressed adrenal function, such as cases of Addison's disease or those on prolonged cortisone therapy. It may also occur in patients who have previously been normal, and these will be discussed here.

Acute hæmorrhagic necrosis of the suprarenal may occur in association with shock and hæmorrhage in such conditions as ectopic gestation, abortion, prolonged difficult labour or accidental hæmorrhage, and also in some cases of septicæmia.

The condition is characterized by profound shock, sometimes with pain in the loin or epigastrium and vomiting, and sometimes with purpura. Most cases are fatal and the lesion is usually only discovered at post-mortem examination. It may be suspected during life if there is shock which is out of all proportion to that expected from the hæmorrhage or injury, and

which does not respond to the usual treatment nor to the administration of noradrenaline.

The immediate need is the intravenous administration of hydrocortisone. Up to 300 mg. a day should be given but dosage is varied according to the clinical response. Later if there is a good response a change can be made to intramuscular or oral cortisone. As well as hydrocortisone there often is an urgent need for the correction of dehydration and electrolytic imbalance so that glucose saline is indicated as well. Accompanying oliguria is usually consequent upon prolonged hypotension, but, of course, may be the result of cortical renal damage as well and will then persist after the blood pressure had been restored to normal.

If the patient recovers cortisone withdrawal must be gradual. In some cases recovery is complete; but when more acute cases have been successfully treated, some will be left with adrenal insufficiency when management should be along the lines for Addison's disease.

Phæchromocytoma. This is a very rare complication of pregnancy, but it is exceedingly dangerous; yet with closer vigilance not only will more cases be diagnosed but they will be discovered early enough for treatment to be undertaken.

This disorder is due to a tumour of the chromaffin tissue of the suprarenal medulla which produces an excess of noradrenaline and adrenaline. Any stress or painful stimulus, or any mechanical disturbance of the tumour, causes the release of these substances and paroxysmal hypertension and tachycardia. Finally acute cardiac failure may occur.

In the attack there is pallor, sweating, headache and sometimes vomiting. Anæsthesia, operations or labour are especially likely to precipitate an attack, and a number of patients have died of so-called shock, the phæchromocytoma only being found at post-mortem examination. Attacks may occur during pregnancy and simulate severe pre-eclamptic toxæmia or concealed accidental hæmorrhage, but also occur during labour or soon after delivery. It is the paroxysmal nature of the attacks of hypertension which should arouse suspicion.

It is not usually possible to palpate the small tumour. Estimation of the urinary excretion of catechol amines may be possible. A dangerous test which is sometimes employed is to precipitate an attack by injection of histamine. The rise of blood pressure which occurs if a phæchromocytoma is present may then be controlled with phentolamine.

If the diagnosis is made during pregnancy it is considered best to deliver the patient by Cæsarean section when the foetus is sufficiently mature. Any hypertensive crisis can be controlled by giving intravenous phentolamine. The tumour is removed later. Noradrenaline infusion is used at operation to counteract sudden hypotension which may occur as a result of removing the tumour.

Thyrotoxicosis. Severe thyrotoxicosis is rarely associated with pregnancy, because ovulation is usually suppressed in the severe cases. The treatment of thyrotoxicosis during pregnancy depends on its severity. In mild cases rest and sedatives may be sufficient to control the disease.

In more severe cases a choice has to be made between surgical treatment and the use of antithyroid drugs; radio-active iodine should never be used during pregnancy. Subtotal thyroidectomy is not more difficult or dangerous during pregnancy, and the patient may be prepared for it by a short course of Lugol's iodine solution, 10 m. three times daily.

Many physicians prefer to use antithyroid drugs. There is some risk of depressing the activity of the fœtal thyroid gland, so that the infant is born with cretinism or a goitre, but the risk is not great and drugs such as carbimazole 15 mg. three times daily are often used.

Myasthenia gravis. The cause of this disease is not known with certainty; but the almost invariable improvement or cure after removal of the thymus gland suggests that it is due to dysfunction of the thymus. The theoretical explanation of myasthenia gravis is that an abnormal thymic secretion is produced that interferes with the formation of acetyl choline by the nerve cells at neuro-muscular junctions. The disease does not appear to affect pregnancy adversely and in the majority of cases improvement takes place, although this is variable; but relapse commonly occurs within three weeks of delivery. Uterine action is normal.

Myasthenia gravis has very rarely been found in the newly born; usually the baby is healthy.

Patients suffering from myasthenia gravis pass through pregnancy satisfactorily if given neostigmine by mouth. It is never an indication for termination of pregnancy or for sterilization. After pregnancy the thymus can be removed and excellent results follow in at least 75 per cent of cases.

DISEASES OF THE SKIN DURING PREGNANCY

Pruritus. Pruritus vulvæ may occur in cases of diabetes (see p. 278) or in any case in which there is vaginal discharge (see p. 101).

Generalized pruritus, often worst over the abdomen, sometimes occurs. Treatment is not very effective, but warm alkaline baths or the application of calamine lotion, phenol lotion or liquor carbonis detergens may be tried. Drugs of the antihistamine group, e.g. mepyramine 50 mg. three times daily may be tried.

⌐ **Herpes gestationis.** This disorder usually occurs after the fifth month of pregnancy and may recur in successive pregnancies. It is believed to be a variant of dermatitis herpetiformis. Pruritus is followed by the appearance

of erythematous papules and vesicles on the abdomen, breasts, flanks, thighs, legs and forearms. The lesions heal without significant scarring. Eosinophilia is usually present. Cortisone may be given systemically, and triamcinolone ointment applied.

Impetigo herpetiformis. In spite of the fact that many textbooks mention this as a complication of pregnancy it is doubtful whether this is a single disease entity. A rare and fatal disease has been described, with an almost confluent pustular eruption. There have been few recent reports.

MALIGNANT DISEASE DURING PREGNANCY

Tragic problems may arise if a young woman with malignant disease becomes pregnant. With the exception of carcinoma of the breast, there is no evidence that pregnancy increases the rate of growth or spread of malignant disease. In some cases surgical or radiotherapeutic treatment can be given without affecting the fœtus, but if that is not the case and the treatment has a reasonable prospect of success it should be applied without regard to the pregnancy, except that after the 32nd week a short delay may be justifiable in the interest of the fœtus. In advanced cases or those in which treatment is unlikely to succeed, such as leukæmia, the fœtal interest may be given more consideration.

Cancer of the cervix is discussed on page 490.

Cancer of the breast, especially the hormone dependent type, which is often seen in younger patients, appears to progress more rapidly during pregnancy, and reactivation of dormant growth may follow pregnancy. If carcinoma arises during lactation it is of a particularly florid encephaloid type and the prognosis is very bad. Unless a breast cancer is already advanced and untreatable termination of pregnancy is therefore justifiable in early pregnancy, and a patient who has already been apparently successfully treated should be advised against becoming pregnant for at least 5 years.

Except in cases of carcinoma of the cervix or breast termination of the pregnancy serves no medical purpose and may add to the distress of the patient.

MENTAL ILLNESS AND CHILDBIRTH

THE childbearing woman, at all stages of pregnancy, labour and in the puerperium, is under psychological and physical stresses. The physical ones are basically of endocrine origin with all their intimate biochemical effects on protein, fat, carbohydrate, mineral, vitamin and water metabolism. The physiology of the pregnant woman is different in great degree from that of her non-pregnant self. Such physiological stresses may alter brain function. Apart from the physiological stresses there may also be pathological ones such as hyperemesis, pre-eclamptic toxæmia and others.

Against the background of physiological and pathological stress there is also psychological stress. There can be few women who have not wondered if the baby they carry will be normal, if they can stand the pain of labour and if they are not losing their sexual attractiveness as their pregnancies advance. They wonder too about the significance of symptoms such as nausea, sickness, heartburn, backache and so on and whether these presage some dire result for themselves or their babies. They know nothing definite about the risks of pregnancy or labour or of what can be done to circumvent them; moreover they are too shy or too fearful of being found ignorant to ask what their symptoms portend. They will prefer to ask someone as ignorant as themselves and all too often this only heightens their fears. Because of this doctors must not expect their patients to be forthcoming about what worries them. Explanation of symptoms and reassurance are essential even for what may appear to be the most minor trivialities. Only so will psychic tension be reduced. The psychological component of everything that happens to a childbearing woman must never be lost sight of. Her emotional reactions to any stimulus are not the same as when she is not pregnant and must not be judged by that standard. She often realizes that she is irrational and yet is unable to change her psychology. To understand the special stresses of childbearing is the key to psychological management and is the basis of many systems of so-called 'natural' childbirth. That these systems are being used by more and more pregnant women is an indication of the importance attached by the laity to a proper comprehension of their psychological problems and no one associated with the care of childbearing women can afford to be ignorant of them.

The degree to which a woman will feel the psychological stresses of pregnancy, labour and the subsequent weeks will depend on her previous knowledge of sexual and reproductive matters, and on her total

life-situation. Her family, friends, neighbours, school and her education in the widest sense of the word will have contributed to this knowledge, which will inevitably be biased and partially incorrect. Nevertheless this is all she has to work on, and it will colour her outlook. It must be remembered that education, even to university standard, does not give immunity from fear, and reading, attending lectures about childbirth and going to relaxation classes of one sort and another may sometimes be symptomatic of excessive apprehension. In the final analysis the psychic tension of childbearing can only be reduced by the sympathy, understanding and tact of everyone who comes into contact with these women, and in this the doctor and midwife must inevitably be the leading figures.

Previous upbringing, education, nutrition, past health and anatomical, physiological and psychological endowment, all determine constitution. A person is the product of everything that has happened to him or her in the past, though the degree in which the various factors enter into present constitution vary from person to person. The same thing may happen to two different people, but the results will vary, so that the final constitution is different.

Since individuals really are unique, it is not surprising that their reactions to the stresses of childbearing, anatomical, physiological, psychological and social, may be infinitely variable. Clinical medicine is concerned with individuals and patients must not be forced into rigid categories—a doctor who does this courts the charge of inhumanity. Although classifications and statistics have to be used as an aid to scientific thought, their limitations for the clinician dealing with individuals, particularly in the realm of psychology, must be realized.

NEUROSES

The response to any stimulus may be normal or abnormal and an abnormal response may be one of over-reaction or under-reaction. The normal response can only be defined in terms of what usually happens and since this shades off imperceptibly into the unusual response, normality cannot be given precise definition. Only the extremes of abnormality are easily recognizable; minor degrees are not so certain that all will agree with the diagnosis. But in the management of the patient the inability to put a label on her disorder is unimportant. Her dis-ease needs treatment and her subjective view of what constitutes dis-ease is what matters, not that of the outside so-called objective observer. No one can be entirely objective in discussing a psychological disorder in someone else, for he has to contend with his own feelings and attitudes to emotional dis-ease in another.

There is no agreed classification of psychological disorder. For present

purposes neurosis will be defined as an abnormal reaction to the stresses of childbearing in which the patient's disorder does not prevent her from having insight into her condition, whereas in the grosser psychoses there is no insight and understanding of the nature of her condition by the patient. By far the commonest neurosis during childbearing has anxiety as the main symptom.

Anxiety neurosis

This may be looked on as an over-reaction to the stress of pregnancy, labour and the puerperium. All childbearing women have fears for themselves and for their babies, as well as for their husbands' and families' reactions to the birth of a baby. The advent of a new life is by no means always an unmitigated joy to all concerned. Added to these fears may be financial and domestic ones. Especially nowadays there are problems due to overcrowding and bad housing, and neighbours and landladies may object to the noise or even the very presence of children. Unmarried mothers, divorcees, and women whose husbands are out of work or in prison have special problems. Therapy in difficult environmental situations is mainly of a social nature in helping to find new accommodation, relieving financial distress, having children placed in day nurseries, and seeing that they are properly cared for either privately or in public institutions when the mother has to come into hospital. In this country the Medical Social Worker is an essential and important member of the obstetric team in reducing the environmental stresses of childbirth. She is an expert in her knowledge of all the services available for patients.

The doctor's place in therapy is in the recognition of the symptoms for what they are, in harnessing the environmental services for the needs of his patient, in reassurance and the treatment of the psychosomatic aspects of his patient's dis-ease. Anxiety may be overt and the patient explicit in what is worrying her, but often the anxiety has to be unearthed from a tangle of apparently unrelated symptoms or seemingly irrelevant questions. Re-assurance must be directed to the alleviation of the patient's fears and much probing may be needed to specify them. Most often anxiety about the baby will be found at the root of the trouble.

The psychosomatic symptoms associated with anxiety require more detailed discussion. Any symptom may have a physical cause and it is imperative that such a cause should be conscientiously sought before a label of psychosomatic is put upon it. Moreover a symptom may not only be caused by anxiety but may be a cause of it. However a symptom arises it inevitably has psychological components. The following symptoms are not a complete list, but are among the most common seen in connexion with childbearing.

Headache is a common symptom of anxiety at any time. It may be due to migraine, sinusitis, infection elsewhere and rarely to toxæmia of pregnancy. When due to anxiety it does not respond to the taking of analgesics and the complaint may be bizarre, as in those who complain of pressure on the top of the head or tight bands running round the head.

Sleeplessness in pregnancy is common, probably because of physical discomfort occasioned by the large size of the abdomen, movements of the fœtus, heartburn or backache. Dreams and fearful thoughts may disturb or prevent sleep and they may be of disaster to the baby or to the mother herself. Although the content of the dreams may not refer directly to child-bearing they may be of nightmarish quality. It is well to look for underlying anxiety so that specific fears may be allayed but some hypnotic should also be given. This will often be a barbiturate such as amylobarbitone 90 to 180 mg. (1½ to 3 gr.) and the dose or preparation must be varied to suit the individual. It is worth noting here that the symptom of *nocturia* is often due to sleeplessness. Because of insomnia the woman gets up to micturate rather than because discomfort in the bladder wakes her up. In such cases urinary infection must be excluded.

The globus hystericus though well-known is not very common. There is an inability to swallow and this may be symbolic of an inability to swallow the pregnancy and all that it implies. Simple explanation and reassurance are usually enough to deal with this discomfort. Nothing too elaborate should be told the patient, for patients with hysteria are usually of emotionally immature type and not too well endowed mentally, so explanations are difficult and not likely to be understood. Indeed more fears may be aroused by the explanations and simple authoritative suggestion is best.

Women of better education and superficial understanding who are able to describe their symptoms and are more articulate are likely to have other subtler and more reactive symptoms. Psychosomatic symptoms must inevitably be coloured by the patient's own image of bodily events. If this image is bizarre the symptoms will be also. The nearer the approach of the body image is to reality the nearer will be the symptoms to those encountered in physical disease, and so more difficult to recognize as being of psychic origin.

The place of *vomiting* as a symptom of neurosis in pregnancy is hard to define. It is possible that it is primarily due to hormonal changes, but its continuance into hyperemesis may be of neurotic origin. However as with all severe symptoms it is difficult to decide whether the neurosis causes the symptom or the symptom the neurosis. It is certain that excessive vomiting has a psychic component and this requires recognition in the treatment. It is probably true that most of the vomiting seen in pregnancy is of organic rather than psychic origin. *Ptyalism* or 'excessive

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salivation' is another neurotic symptom. The patient spits out her saliva rather than swallowing it. This too may be a symbolic rejection of pregnancy.

Breathlessness is very often a symptom of anxiety in pregnancy, in the absence of heart disease. It is with some surprise that one sees a patient with this symptom lie down flat on the examination couch without a hint of dyspnœa. Of course any breathlessness must be interpreted in the light of the fact that increasing weight and bulk make all pregnant women to some degree breathless on exercise.

Cardiovascular symptoms of anxiety include palpitation, fainting and flushing. Of course physical causes for these must be excluded. Fainting especially may be due to hypotension or impaired cardiovascular reflexes or the supine hypotensive syndrome (see p. 170). Disturbances of the vestibular mechanisms and *petit mal* may also need consideration.

Pain as a psychosomatic symptom is difficult to evaluate. It is all too easy to dismiss the minor aches and discomforts of pregnancy as of little account. This usually only means that the doctor has taken too little trouble to find out the real cause in such conditions as carpal tunnel syndrome, interchondral joint subluxation, backache, mild pelvic osteoarthropathy especially of the symphysis, meralgia paræsthetica, sciatica and so on. All too often the explanation is given that the 'baby is pressing on a nerve'—which often only shows that the doctor is making no intellectual effort, and moreover he is liable to be making his patient's fears worse than they were before. Pain always merits the most careful investigation.

Frequency, urgency and nocturia are most often due to some organic disorder in the urinary system, especially infection or vascular congestion. Sometimes they may be due to anxiety.

Depression

Depression as a symptom may belong with both neurotic and psychotic disorders, but the psychoses require the help of a psychiatrist and only those patients who have insight will be considered in this section. Depression and anxiety often go together, for the anxious patient may be so overwhelmed by her fears as to be depressed by them, especially when she feels that nothing can be done about them or when she has taken her heart-cry to the doctor and he has dismissed it lightly, or when she is similarly treated by one of her family such as her husband or mother, from whom she might reasonably expect to gain sympathy in her distress.

Depression as a response to trying circumstances may be normal, but can be excessive and as such is known as reactive depression. When the patient is depressed with no obvious reason in her external circumstances and when she can give no adequate reason to herself or her doctor for her

symptom this is endogenous depression. If such endogenous depression is associated with symptoms, especially psychosomatic symptoms, of anxiety it is called atypical depression. She may be weepy and unhappy and difficult to rouse from her mood. Headache is common, and so is waking in the early morning. There is difficulty in concentration and maybe failure to carry out the normal household or other tasks. In a patient who has previously had a normal personality the episode will pass in time, but meanwhile she is apt to be a trial to herself and her husband and family, because none of them can see any reason why she should be so miserable, and the immediate family is therefore likely to be unsympathetic. In endogenous depression there is often early morning waking, loss of appetite, loss of interest and concentration, all of which symptoms may help to differentiate a pathological depression from a reactive or justified depression. Many psychiatrists look upon this state as having an organic basis centred on the hypothalamus, though the hypothesis lacks experimental verification. But this is an interesting theory to the obstetrician who observes the well known and almost universal depression seen in the puerperium.

On or about the fourth day of the puerperium nearly all women feel miserable and depressed and often weep and are easily upset by the most trivial stimuli. They realize that their behaviour is unreasonable and can do nothing about it. This is a time of the most intense physiological activity. The hormones of the placenta have been withdrawn by delivery and their concentration in the blood has fallen precipitously; the pituitary is coming into action in its control of lactation, of involution and of mineral and water metabolism which are so very different from that of pregnancy. In addition the patient has passed through the fire of labour and found the succeeding days something of an anticlimax. She is no longer the full centre of interest that she was during labour and some of her thunder is stolen by the baby on whom more care seems to be lavished than on her. The medical and nursing staff apparently lose some of their interest in her too, and in hospital she is cut off from the comforts of her home environment. Lactation is commencing and her breasts frequently hurt and suckling may be painful. All in all it may be a very depressing time for her, but its especial interest lies in the background physiology of which almost nothing is known, although it can hardly be doubted that the hypothalamus is in a state of rapidly changing activity.

The treatment of reactive depression is to remove as many of the distressing circumstances that surround the patient as possible. To ensure restful sleep with drugs can be a great restorative, and should never be neglected. In endogenous or atypical depression altering the external circumstances cannot be of any great help. The aim must be to tide the patient over the episode knowing that if her previous personality was good it will pass. The duration of the episode of depression is quite unpredictable, but it may be

cut short by the use of drugs. The depression of the early puerperium is usually over in two or three days. If the depression persists or is associated with confusion or abnormal behaviour the advice of a psychiatrist should be sought. Any threat of infanticide or of suicide must be regarded seriously.

Drugs used for atypical depression have only an empirical basis. A useful drug for mild cases is amphetamine in doses of 5 mg. once or twice daily. It can cause restlessness, insomnia, palpitations and tachycardia, so that the dose should be adjusted to prevent these side effects. Whilst it is being given a hypnotic such as amylobarbitone should be given at night. Amphetamine is a drug of addiction and should only be used for short periods. In any case in which depression is at all prolonged the advice of a psychiatrist should be sought.

Other drugs used in puerperal depression are imipramine and the whole group of mono-amine oxidase inhibitors. Imipramine (Tofranil) is given in doses of 25 mg. three times daily. It may cause dryness of the mouth, sweating, dizziness and hypotension and, more rarely, excitement and insomnia. The mono-amine oxidase inhibitors are legion, but include phenelzine dihydrogen sulphate (Nardil) which is given in doses of 15 to 30 mg. three times a day. Side effects are similar to those of imipramine, but the danger of this group of drugs in obstetrics is that when pethidine or morphine are given to patients taking them coma or even death may occur. If patients are already taking one of this group of drugs the administration of them should cease at least two months before the expected date of delivery. This should be done with the agreement of the psychiatrist who should be persuaded to find some other treatment for his patient. A doctor should always tell a patient when she is having mono-amine oxidase inhibitors and warn her obstetrician, for so often patients who are taking these drugs tell no one that they are doing so and this may be extremely dangerous. An incomplete list of these drugs for reference is iproniazid (Marsilid), benzyl pivaloylhyrazine (Tersavid), isocarboxazid (Marplan), phenoxypropazine hydrogen maleate (Drazine), phenelzine dihydrogen sulphate (Nardil), tranylcypromine sulphate (Parnate), nialamide (Niamid).

A few patients may be recommended for electro-convulsive therapy by the psychiatrist. With modern methods using muscle relaxants electro-convulsive therapy can be given to women at any stage of pregnancy but it is wise to delay treatment if possible till after the first 3 months of pregnancy to avoid causing abortion, and not to give it in the last 2 months of pregnancy to avoid causing premature labour. After delivery of course there are no objections to electro-convulsive therapy and few to the use of mono-amine oxidase inhibitors.

It should be remembered that drugs may reach and have an adverse effect on the fœtus, and this is especially so during the formative weeks of

the first 3 or 4 months of pregnancy. It is particularly worrying that virtually all drugs used for these cases have some effect on the nervous system. Little enough is known of these actions in the adult and nothing whatever of their effects on a developing nervous system. The prescriber for the pregnant woman must exercise caution. It may seem over-conservative to prescribe only a few well-tried and well-known drugs during pregnancy, but if this course is followed there will never be the need for the doctor to reproach himself with the birth of a malformed or dead baby.

The psychological problems of pregnancy and the neuroses associated with it still receive insufficient attention. Much can be done to alleviate the distress they cause, although this involves the expenditure of time and requires sympathy, insight and comprehension on the part of the doctor, and of all those who care for women in pregnancy and labour.

PSYCHOSES

The psychoses associated with pregnancy are matters for the psychiatrist. Psychotic patients may come within the purview of the obstetrician either because the psychosis was known to exist before the pregnancy or because it began at some time during it. In either case co-operation with the psychiatrist is essential. It is worth emphasizing that pregnancy is not a cause of psychosis but it may be a factor in the breakdown of a previously psychotic personality.

The symptoms of the major psychoses are not different in pregnancy from those at any other time, and for a full description text-books on psychiatry must be consulted. In *schizophrenia* there are disorders of thought, emotional incongruity, disturbed conduct and hallucinations. During childbearing the disorders of thought are as they are at other times, with incoherence and irrelevance. Emotional incongruity occurs when the patient does not feel as she ought to feel in a given situation. Thus there may be an aversion to the husband or the baby, and rarely she may even attack her child. There may be feelings of unworthiness. Her speech may be irrelevant, whilst hallucinations may be of voices or visions. This sort of picture may arise at any time, including the puerperium. It has already been pointed out that this time is one of especial stress, and if the patient has the constitution of a schizophrenic then it is not surprising that this is a time at which the disorder will show itself. A special watch should be kept on all patients in the puerperium who show any sort of emotional disturbance or incongruity of thought. An inability to sleep well is often a warning sign. Frequently relatives will note the patient's disturbance before the medical or nursing staff, and their observations should be given due weight. Other patients too may be of help in drawing attention to the fact that something is amiss. Schizophrenic patients and paranoid

ones should be seen without delay by the psychiatrist for they constitute a special danger to themselves by suicide and to their babies and those of other women by attack. They must be treated away from the maternity unit.

In *manic-depressive psychosis* too the symptoms arising during childbirth are essentially the same as those in non-pregnant women. A depressive episode may begin during pregnancy of after a stillbirth or neonatal death. In the milder cases it is obviously not possible to distinguish between the beginnings of a major psychic disorder and a slight exaggeration of the normal response to grief. No sharp division can be made between neurosis and psychosis, but in examples of abnormal behaviour it should be possible to recognize those who ought to be seen by a psychiatrist.

Puerperal psychosis is not now regarded as a specific entity. Psychosis in the puerperium has no special features which distinguish it from other psychoses, except that the patient has recently had a baby. As previously emphasized, if the patient has a constitution liable to break down into a psychotic state when under stress the puerperium is one such time. In the past puerperal psychosis was related to puerperal pyrexia and thought to be a toxic phenomenon. There is no doubt that pyrexia can disturb thought and feeling, and may cause delirium and even hallucinations, but these symptoms all disappear as the temperature falls. Since antibiotics have cut short the duration of febrile illness such disturbance of cerebral function over long periods is not now seen, and puerperal infection *per se* does not seem to be a special cause of psychosis.

TERMINATION OF PREGNANCY IN MENTAL ILLNESS

This is a large subject which can only be outlined here. There are medical, psychological, social, legal, moral and religious aspects, and different people will give different weight to each of these factors. Disagreement on whether it is proper to terminate a pregnancy in an individual patient is inevitable. There can be no absolute rights and wrongs except for those of deep religious conviction.

The legal aspect of the therapeutic termination of pregnancy is discussed on p. 566. Termination can only be justified if continuation of the pregnancy will impair the mother's health or threaten her life. It is always prudent to secure an independent medical opinion and in psychiatric cases the two doctors usually involved are the psychiatrist and the obstetrician. However it must be realized that it is the person who actually performs the operation who is liable to criminal proceedings and he therefore carries the final responsibility, even though he is advised by his colleague.

In mental disease, where the approach is still empirical, prognostication is even more difficult than in physical disease. Moreover, almost every layman fancies himself to be a capable psychologist who understands the mainsprings of human action. The critics of the psychiatrist and especially of the obstetrician in cases where termination of pregnancy is performed or refused are legion, but when in all honest conscience the two specialists believe their advice to be the interests of their patient they should proceed without fear of their censors.

Sterilization may be needed at the same time as termination of pregnancy in the case of a woman who has a psychosis which considered unlikely to improve with time. Although there is evidence of a genetic factor in the causation of psychoses of schizophrenic or manic-depressive type, as well as of some of the other groups, the genes responsible are recessive, and there is usually no justification for recommending sterilization to prevent the birth of psychotic children. The children of one psychotic parent are far more likely to be normal than psychotic.

MULTIPLE PREGNANCY

Twins occur about once in eighty pregnancies, triplets about once in 6,000, quadruplets about once in 500,000, that is roughly 80^1, 80^2, 80^3 and so on. Quintuplets are exceedingly rare, the famous Canadian quins being especially remarkable, in that they survived the risks of birth and infancy inherent in multiple pregnancy.

Multiple pregnancy may be an inherited tendency, as it is well known to occur more often in certain families. Statistics have shown that the frequency of paternal and maternal influence on twinning is about equal, and this applies to both binovular and uniovular twins. The faculty of uniovular twinning may presumably be inherent in either sex cell, but the production of two ova at the same time by the mother is difficult to explain as due to paternal influence. The frequency of twin births is maximal between the ages of 35 and 40, especially when the twins are binovular, and a woman who has already given birth to twins is ten times more likely to have another multiple pregnancy than one who has not previously had twins.

VARIETIES

Twins may be binovular or uniovular.

Binovular twins are developed from two ova, arising in a single Graafian follicle, or from two follicles which may or may not be in the same ovary. This variety of twins is three times as common as the uniovular variety. The children may be of the same or different sex, and are not more alike than is usual with members of the same family. As they are developed from separate ova, they have separate and distinct placentæ; sometimes the placentæ are loosely jointed at their margins, but there is never any anastomosis between their blood vessels. Each fœtus has its own amnion and chorion, so that four layers of membranes are to be found where they are in contact (Fig. 83).

Uniovular twins are developed from a single ovum, which after fertilization, has undergone complete division to form two embryos. It is possible that such an ovum may contain two nuclei, or separation may occur in the early stages of segmentation, or two germinal areas may be formed in one blastodermic vesicle. When a single germinal area becomes incompletely divided, some form of double monster results. Many varieties of conjoined twins have been described; they may be joined in the region of the sternum, or by the pelvis, or by the head.

Uniovular twins are always of the same sex, and are often remarkably alike in their physical and mental characters. Presumably the arrangement of genes in the chromosomes is identical, and inherited characteristics such as blood groups are necessarily the same. Uniovular twins which arise as a result of very early division of the ovum each have a complete set of membranes (amnion and chorion); those which arise by later division have
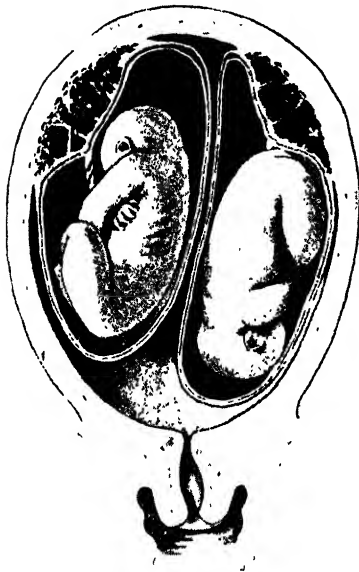
FIG. 83. Binovular twins.
The placentæ are separate and each fœtus has its own chorion and amnion.
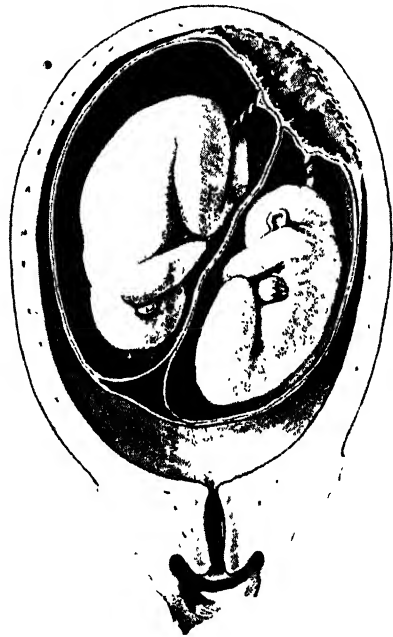
FIG. 84. Uniovular twins.
One placenta, two amnions and one chorion.

only one chorion but have separate amniotic sacs (**Fig. 84**). The umbilical cords are usually separate, but the fœtal circulations always communicate by anastomoses in the placenta.

The communication between the two circulations in uniovular twins may cause unequal development of the fœtuses, and sometimes fœtal death. Very occasionally one fœtus will perish early in pregnancy and be retained *in utero* until term, becoming compressed and mummified, when it is known as a *fœtus compressus* or *fœtus papyraceus*. The more frequent occurrence of hydramnios with uniovular twins is probably related to the common placental circulation.

Triplets may be developed from a single ovum, or from two or three ova.

The placenta and membranes will be arranged in the same way as in twins according to the manner in which development has taken place.

Quadruplets and *quintuplets* are similarly developed.

It is theoretically possible for two ova produced in one ovulatory cycle to be fertilized at two separate acts of coitus. This is called *superfœtation*, but there is no reliable evidence that it has ever occurred in the human. *Superfecundation* is the fertilization of an ovum produced in a succeeding ovulatory cycle after pregnancy has begun, but there is even less human evidence for this.

DIAGNOSIS

During pregnancy the presence of twins should be suspected from various symptoms and signs. All the symptoms of pregnancy, whether troublesome or not, may be exaggerated. Thus the nausea and sickness of the early months may be more pronounced. If the patient has already borne children she will often note an unusual rate of abdominal enlargement or complain of excessive fœtal movements. Towards the end of pregnancy the patient is more likely to suffer from anæmia. The prophylaxis is to ensure an adequate diet and to prescribe additional iron and folic acid. It is especially important too, to check the hæmoglobin level in the later weeks of pregnancy to avoid overlooking not only iron deficiency anæmia but also unsuspected megaloblastic anæmia, which is more common in multiple pregnancy. She is more likely to develop toxæmia of pregnancy. The tendency to œdema, varicose veins of the legs and hæmorrhoids is greater and the patient may state that she easily tires and becomes short of breath, and she may suffer undue discomfort owing to the large size of the uterus.

In multiple pregnancy the uterus at term is larger than would be expected for the period of amenorrhœa, and the girth, as measured at the umbilicus, may be several inches greater than would be expected at that period of the pregnancy. Hydramnios may also add to the enlargement and is more frequent with uniovular twins.

Undue enlargement of the uterus should always arouse suspicion, and the diagnosis is simple if two fœtal heads can be felt. Both backs and both breeches may be identified and an unusual number of small parts may be felt (Figs. 85 and 86). The diagnosis is made more certain by hearing two fœtal hearts, recognized as two by their points of maximal intensity being at different positions, the sounds being lost between them, and the rates, counted at the same time by two observers over at least one minute, differing by at least ten beats. When both hearts can be heard in one area, they will be found to synchronize intermittently. Hydramnios makes the diagnosis of twins by palpation and auscultation extremely difficult. An

X-ray should always be advised in the second half of pregnancy when twins are suspected. Radiological examination not only confirms the diagnosis but might also show evidence of gross abnormality or of conjunction, and so provide a warning of difficulty with vaginal delivery.

The diagnosis of twins is sometimes missed until the birth of the first twin. The high position of the fundus, palpation of a second fœtus, and the
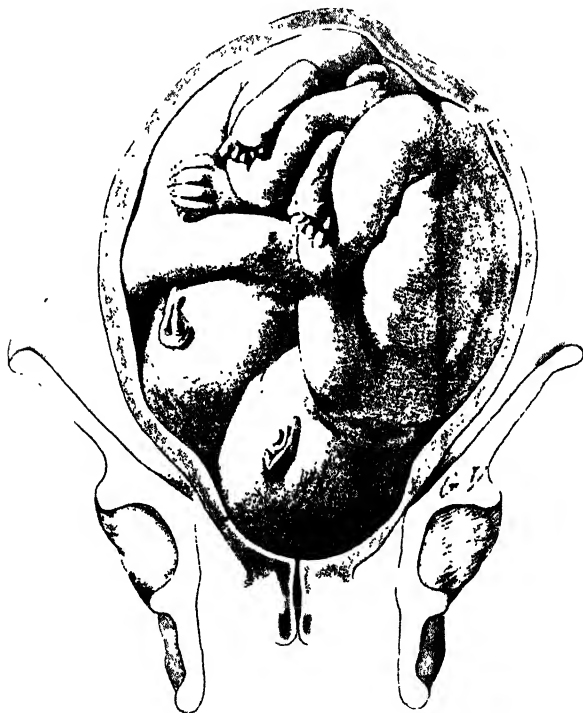
FIG. 85.   Twin pregnancy. Both presenting by the vertex.

Fœtuses lying alongside one another. Both heads could probably be felt, one at the brim and the other above it in the iliac fossa. One back and an unusual number of small fœtal parts would be recognized and possibly two breeches in the fundus.

presence of a second bag of membranes and presenting part then make the diagnosis clear. *Ergometrine* given routinely to prevent postpartum hæmorrhage may be dangerous for an undiagnosed second twin. The contraction of the uterus induced by the ergometrine may reduce the placental blood flow or separate the placenta and distress or kill the fœtus by anoxia.

Malpresentations are common with twins. In about 45 per cent of cases both present by the head: in about 35 per cent one fœtus presents by the

head and one by the breech: in about 10 per cent both present by the breech, and in about 10 per cent a transverse lie is associated with either a
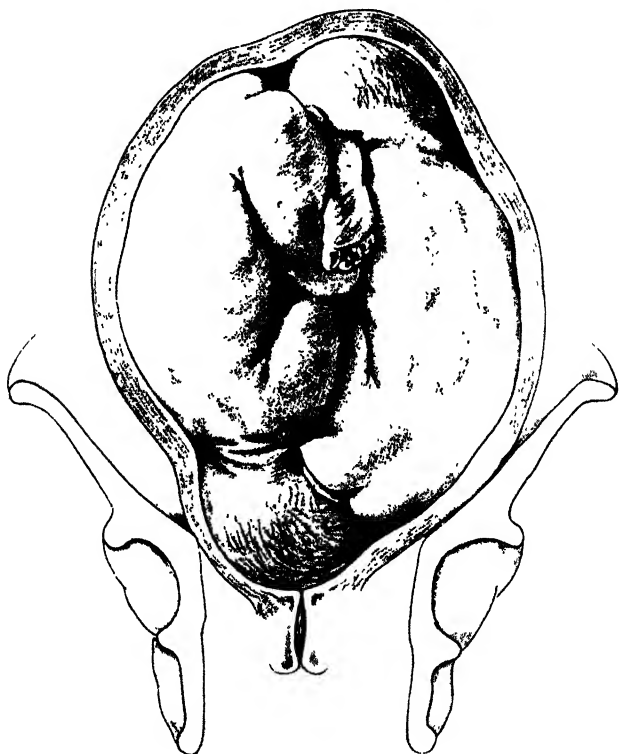
FIG. 86.   Twin pregnancy.

First presenting by the vertex, second by the breech: fœtuses lying alongside one another. This offers the easiest diagnosis. One head would be felt at the brim and one at the fundus; two backs with the small parts in the groove between would be palpable and two points of maximal intensity of the fœtal heart-sounds could be made out, one on the right and below the umbilicus and the other on the left and above.

vertex, a breech or a second transverse lie. The second twin may undergo spontaneous version during or after the birth of the first. It is said to be rare for both to be transverse.

PROGNOSIS

The risk to the mother is increased by the following factors:

1. Greater tendency to toxæmia, eclampsia and anæmia during pregnancy.
2. Abnormalities of labour such as malpresentations, and occasionally uterine inertia.

3. Danger of postpartum hæmorrhage.

4. The incidence of placenta prævia is increased as the large placenta often encroaches on the lower segment.

5. Possible increased risk of sepsis if labour is complicated, or if severe bleeding occurs.

Many of the discomforts of pregnancy are increased, e.g. vomiting, tiredness, breathlessness, heartburn, varicose veins and piles.

The prognosis for the babies is decidedly worse in multiple than in single births, about 15 per cent being stillborn or dying soon after delivery.

1. Prematurity is the greatest risk that all twins run, not only during birth but during the neonatal period too. The rate of growth of the fœtuses is slower than in a single pregnancy after the 28th week, and the reduced rate of growth begins when the total weight of the twins is in the region of 7 pounds. The cause of this is not to be found in the size of the placenta, for at any given placental weight a single fœtus will be larger than a twin.

2. Complications of labour, such as malpresentations, placenta prævia and prolapsed cord are more common, and one twin may interfere with the descent of the other. The second twin may also be endangered by retraction of the uterus and premature separation of the placenta.

3. Death *in utero* affecting one or both twins may be caused by placental insufficiency associated with toxæmia, or from accidental interruption of the circulation.

MANAGEMENT OF PREGNANCY

The duration of twin pregnancy is very variable, it tends to be short. In a study concerning several hundred twin pregnancies only 83 per cent reached the 36th week, and that 9 per cent ended before the 34th week. The time to expect the majority of twin pregnancies to end, therefore, is somewhere between the 34th and 36th week.

The added care that should be given to the patient with a twin pregnancy results from the greater frequency of certain complications.

Pre-eclamptic toxæmia is found at least three times more often than in single pregnancy, yet on balance it seems to run a much less severe course. Even eclampsia holds a much lower risk for both mother and baby. This is not to say that everything possible should not be done to try to prevent it. The fact that prematurity is the most serious complication for the baby in both toxaemia and twins should be enough to guarantee constant vigilance against the onset of toxæmia in multiple pregnancy.

Anæmia. Iron deficiency anæmia is common in ordinary pregnancy. The demand made by two or more fœtuses makes hypochromic anæmia much more common; it is, therefore, essential to prescribe iron, and frequently to check the hæmoglobin level from mid-pregnancy onwards. Defective

absorption can then be made good in ample time by parenteral iron therapy. If intravenous iron therapy does not produce the expected improvement in the hæmoglobin level the possibility of megaloblastic anæmia (see p. 265) should be considered. This complication is relatively more common with twins, and on the diagnosis of twins folic acid should be given proplylactically until delivery.

Hydramnios. The incidence of this in multiple pregnancy is a good deal higher than with single pregnancy, and is commoner in uniovular twins. The upper rather than the lower sac is usually involved; toxæmia is more common when it is present.

Antepartum hæmorrhage. Both accidental hæmorrhage and placenta prævia are slightly more common in twin pregnancies. It would be natural to anticipate finding placenta prævia more frequently because of the increased bulk of the placenta, even with uniovular twins.

The antenatal care then of a patient with twins should be intensified in order that toxæmia, anæmia, hydramnios, antepartum hæmorrhage and premature labour can either be avoided or discovered and treated. To this end the patient should be seen more frequently than usual from mid-pregnancy onwards. It is now common practice to admit patients with more than one fœtus to hospitals for rest in bed from about the 30th to the 35th week. It is by no means certain that this will prevent premature labour, but it may increase the placental blood flow and so improve fœtal growth. In addition, many patients are uncomfortable while carrying twins and may need admission on this account.

MANAGEMENT OF LABOUR

All preparations should have been made for the resuscitation and care of premature babies. Because this is only possible in hospital and because other complications of labour are relatively frequent all cases of twin labour should be under hospital care.

The first stage of labour is managed exactly as in any other case. Sometimes painful contractions occur before labour is truly established but once labour has really begun it is not often prolonged.

Because of the shifting relationships of the fœtuses it is often difficult to be sure that both fœtal hearts are still beating. Nevertheless an effort must be made to locate both of them. Provided that one can be heard at a normal rate no interference should be contemplated for fœtal distress. In general, Cæsarean section will only be performed for prolonged delay in the progress of the labour, or in rare cases in which both fœtuses are lying transversely.

The second stage should be also normal. As in other cases the indications for forceps delivery or breech extraction are those of undue delay, maternal

distress or fœtal distress. Unless the perineum is very lax, an episiotomy under local anæsthesia should be performed routinely for the protection of the premature baby's head.

After the first baby is delivered the maternal end of the umbilical cord must be secured with care, since if the twins are uniovular bleeding from here may exsanguinate the second twin through anastomoses in the placenta.

It is after the birth of the first twin that the problems usually arise, and it is the second twin which is mainly at risk. It may have to be delivered without delay and therefore an anæsthetist must be ready in the labour ward during all twin deliveries, so that any obstetric manoeuvre may be performed.

Usually both babies are delivered before the placentae, but rarely, with binovular twins, the placenta of the first twin will come away before delivery of the second fœtus. Because the volume of the uterus is reduced by the delivery of the first twin there may be separation of the placenta on which the second twin depends, when there will be some bleeding per vaginam and fœtal distress unless the delivery is soon completed.

It is essential that the lie of the second fœtus should be longitudinal. The abdomen is palpated, and if the lie is oblique or transverse external version is performed to place one pole over the dilated cervix. It is immaterial which pole is made to present, though the breech has some advantages over the head. The fœtal heart rate is counted, for if the fœtus is distressed immediate delivery is needed. The cause of the distress will usually be premature separation of the placenta or interference with its blood supply. However it may be due to prolapse of the cord since the lie may be oblique or transverse and the presenting part high above the brim. Vaginal examination should always be performed to exclude prolapse of the cord as soon as the membranes of the second sac rupture. If all is well no immediate interference is needed, though the fœtal heart should be listened to every few minutes. Uterine contractions are usually in abeyance for some minutes after delivery of the first twin. When they begin again the delivery of the second twin is usually quite rapid, since the cervix has already been fully dilated, and delivery is conducted in the usual way, whether the head or the breech comes first.

If the uterine contractions do not return in about 5 minutes after the delivery of the first baby the forewaters should be ruptured by Kocher's forceps or some other suitable instrument. This should be done even if there is no fœtal distress. If there is fœtal distress the membranes should be ruptured at once and delivery effected. In the case without distress a vaginal examination must be made to exclude prolapse of the cord. This is omitted when there is fœtal distress for then immediate delivery is the treatment. In the past it was customary to wait some time before rupturing the

membranes provided there was no fœtal distress. During this interval the cervix sometimes partially closed down, and it has now been found that fewer babies are lost when the interference is relatively early than when it is delayed too long. Most often, after artificial rupture of the membranes the second fœtus is delivered normally without further trouble.

When the second fœtus is distressed or if its cord prolapses it must be delivered with reasonable expedition. The patient must be anæsthetized so that any manipulations are immediately possible. The most unpleasant problem to find is that of the head presenting but high above the pelvic brim, for this may mean having to apply the forceps at a high level, a procedure always fraught with danger. Nevertheless this may have to be done, exercising the greatest care, and with an assistant applying abdominal pressure to bring the fœtal head as close to the brim as possible. The alternative to this procedure is to turn the baby round so that the breech presents and a leg can be pulled upon to effect delivery. The version may be possible by external means if there is still enough liquor left, but it is usually best to use internal version since the hand can easily be introduced into the uterine cavity through the previously dilated cervix. Even this carries the danger of rupture of the uterus if persisted with in the presence of strong uterine contractions. It is because of this special difficulty with the high head that when the abdomen is palpated after delivery of the first baby and external version is required it is best to bring the breech to present. It is then comparatively easy to reach within the cavity of the uterus and pull down a leg if necessary and ultimately to extract the baby.

The third stage of labour does not often present undue difficulty. A prophylactic injection of ergometrine should be given with the birth of the second twin and the placenta delivered in the usual way shortly afterwards. There is an increased risk of post-partum hæmorrhage because of the large size of the placental site, so that part of the placental attachment may be in the lower uterine segment where contraction of the muscle is relatively ineffective in closing blood sinuses. Post-partum hæmorrhage after twin delivery is treated in the usual way.

Locked twins

This is a rare complication, its incidence being assessed at 1 in 1000 twin labours, but when there is unexplained delay in the second stage it should be considered, and the possibility of conjoined twins should not be forgotten. An X-ray during labour may be compared with any X-ray taken during pregnancy, and the final diagnosis may be by examination under anæsthesia. Although it is seen so uncommonly it is very dangerous to the fœtus, usually the leading one.

The commonest situation is when the first twin presents as a breech and the second as a vertex. The chin of the after-coming head of the first twin

is caught above the fore-coming chin of the second, and if disengagement is not effected quickly the delay ends fatally for the first. In these circumstances the after-coming head of the first twin should be decapitated in order to free and deliver the second, the decapitated head being delivered

FIG. 87. After-coming head of the first locked with the fore-coming head of the second.

by fundal pressure or forceps later. The other forms of locking, are less common and occasionally the heads are merely in collision at the brim. The principle of treatment in twin locking is disengagement when possible and assisted delivery; when this is not possible and both fœtuses are still within the uterus and one or both are alive, Cæsarean section has a place.

ABNORMAL UTERINE ACTION

WHILST our knowledge of the factors initiating and controlling uterine contractions remains incomplete it is difficult to define and classify the different types of abnormal uterine action. This difficulty is reflected in the variety of the terms used, and the varied interpretation of these terms by different authors. Before discussing the abnormal, it is essential to consider the action of the uterus in normal labour divided into its three stages.

First stage. The upper and lower uterine segments have different rôles to play during labour. The more active rôle is played by the upper uterine segment showing three separate forms of muscle behaviour; contraction, retraction and relaxation. By contracting, the upper segment compresses the gestation sac containing the fœtus and raises the intra-uterine tension from 5 to 10 mm. Hg during the resting phase to 50 mm. Hg at the height of the contraction. As a result pressure will be directed towards the line of least resistance, that is towards the lower segment and cervix, and utilized to help in dilatation. Retraction, by holding and making good much of the advance achieved by the preceding contraction, has been called the 'ratchet mechanism' and is important in achieving progressive dilatation. The term retraction means that the uterine muscle retains some tone between contractions. It is owing to retraction that the muscle fibres of the upper segment become increasingly shorter and thicker, causing thickening of the wall of the upper segment which contrasts markedly with the thinner wall of the lower segment.

It is natural that where the relatively thick upper segment meets the decidedly thinner lower segment, there will be a ledge or rim running round the inside of the uterus. This is the physiological retraction ring, and it is present in every normal labour. If there is obstruction to the expulsion of the fœtus, this ring will become more obvious because the upper segment, working harder, will become thicker, whilst the lower segment becomes thinner; the result is the appearance of an exaggerated or pathological retraction rim called Bandl's ring, and is pathognomic of advanced obstructed labour. Relaxation of the upper segment between contractions is of the utmost importance, not only in avoiding muscle fatigue, but also in allowing the normal placental circulation to be resumed, which is an essential safeguard against increasing fœtal anoxia.

The lower segment is far less active than the upper segment, although it contracts synchronously with the upper segment. The lower segment

becomes stretched and therefore thinned by the much stronger contractions of the upper segment, but it retains sufficient tone to pull on the ring of the cervix and to dilate it.

Playing this relatively passive part, the lower segment and cervix are pulled up and dilated over the presenting part of the fœtus by the active contraction and retraction of the upper uterine segment. It is probable that the pressure of the presenting part of the fœtus on the lower uterine segment and cervix, acting through a local reflex, stimulates the normal contractions of the upper segment during this stage of labour; it is certainly true that in cases in which the presenting part is not well applied to the lower segment and cervix, for example in cases of occipito-posterior position and disproportion, labour is often complicated by poor uterine action. This reflex from the lower part of the uterus to the upper part is referred to in the phrase 'uterine polarity'.

Second stage. The stage of expulsion of the fœtus. This is brought about by the powerful contraction and retraction of the upper uterine segment, assisted by the bearing-down efforts of the patient, consisting of contraction of the abdominal muscles and diaphragm and relaxation of the pelvic floor. These forces are stimulated by the pressure of the presenting part on the pelvic floor once it has escaped through the fully dilated cervix. This is the reason why the patient generally experiences a desire to bear down as soon as the second stage of labour begins.

Third stage. The separation and expulsion of the placenta. Rhythmical contraction and retraction of the upper uterine segment cause separation of the placenta and its expulsion into the vagina.

There are no very definite standards of normal uterine action during labour, and the action can be judged clinically only by observing the strength and frequency of the contractions, and noting their effect on dilatation of the cervix and expulsion of the fœtus.

More accurate methods of recording uterine contractions have been used to study abnormal action, and the effects of various drugs and anæsthetics upon the contractions:

1. By a rubber bag inserted through the cervix into the lower segment but outside the membranes. This bag is filled with water and connected by rubber tubing with a mercury manometer, and the variations in pressure are recorded on a slowly moving drum.

2. Tokometry. A strain gauge is applied to the mother's abdomen which will respond to changes in the shape of the uterus occurring during contractions. The variations may either be recorded directly by an arm writing on a moving strip of paper, or the apparatus may be modified to make the recordings electrically.

3. By inserting a fine polythene tube through the abdominal and uterine walls direct into the amniotic sac, and recording the changes of pressure inside the uterus by means of a specially sensitive oscillograph.

4. Electro-hysterography—the measurements of changes in electrical potential as a result of uterine contractions.

The records obtained by these methods show bearing-down efforts accompanying second stage contractions, and superimposed lines due to coughing, vomiting, and even fœtal movements are easily recognized.
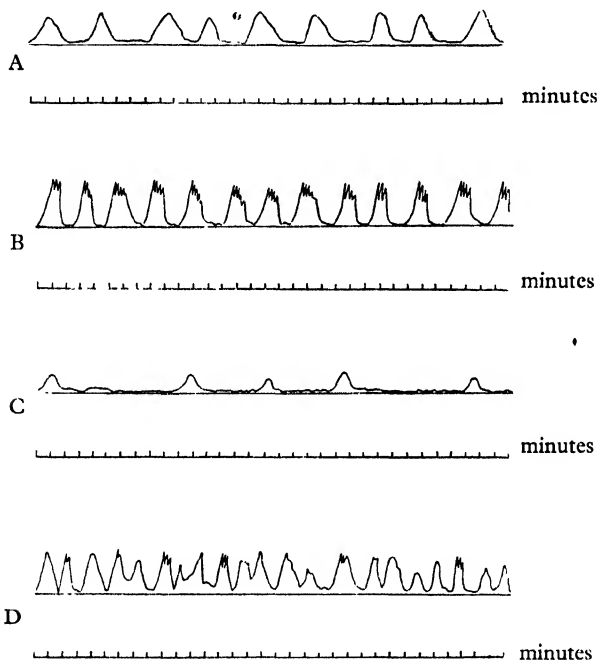
FIG. 88.   Graphic records of uterine action.

A. Uterine contractions in normal first stage.
B. Uterine contractions reinforced by bearing down efforts in normal 2nd stage.
C. Infrequent contractions in uterine inertia.
D. Colicky action of the uterus with occasional bearing down efforts before the cervix is fully dilated.

Recent experimental work, particularly with tokometers placed on different parts of the uterus to make simultaneous records of the uterine contractions, has thrown considerable light on uterine activity.

The following characteristics in the action of uterine muscle have been demonstrated during normal labour.

1. During a contraction the fundus of the uterus contracts more quickly, forcibly, and for a longer period than the rest of the uterus. The middle

zone contracts more slowly, less forcibly, and for a shorter period than the fundus, whilst the lower segment and cervix remain in a passive state of low tone and normally the lower segment only contracts very weakly.

This is known as the gradient pattern of contractility with fundal dominance characteristic of normal labour.

2. A contraction begins at a point near the uterine cornu on one side. Sometimes contractions start on the left, sometimes on the right, and the side of origin of the contraction wave may vary in successive contractions. From this point the wave spreads throughout the whole myometrium. The contractions are not only more forcible in the upper segment, they are also more prolonged.

It has also been demonstrated that the normal contractions of the uterus during pregnancy, prior to the onset of labour, differ from those described above in that the whole of the uterus including the lower segment and cervix contract at about the same intensity. This non-gradient pattern of contractility without fundal dominance occurs in false labour, and is some-times seen in cases of incoordinate uterine action.

At the onset of normal labour uterine contractions occur at intervals of 15 to 20 minutes, increasing in frequency as the labour progresses, so that by the end of the first stage the contractions last for 60 to 90 seconds, and usually pain is felt after the uterus begins to contract, and passes off before the contraction has finished.

Classification of abnormal uterine action

(1) Abnormally weak action (with normal spread of contraction wave).
   I. Primary uterine inertia.
   II. Secondary uterine inertia (Uterine exhaustion).

(2) Abnormally strong action (with normal spread of contraction wave).
   I. No obstruction—precipitate labour.
   II. Obstructed labour—exaggerated upper and lower segment response.

(3) Disorderly uterine action (abnormal pattern of contraction wave).
   I. Incoordinate uterine action.
      (a) Hypertonic lower segment.
      (b) Localized tonic contraction (contraction ring).
      (c) Generalized tonic contraction.
   II. Cervical rigidity.

Before going on to describe the clinical aspects and management of the various kinds of abnormal uterine action, certain functions will be briefly examined to find out whether or not they have any bearing on the ætiology. It might be imagined that since so much has been learned from examining

uterine function by instrumental recordings, management in labour would now be specific, simple and effective, but it must be confessed that progress has been disappointingly slow, especially in the application of this knowledge to the clinical field. The reason undoubtedly is that the problem is a complex one, concerned as it is not only with uterine musculature of varying degrees of developmental imperfection, but also with such diverse factors as endocrine influence, somatic type, disproportion, parity, emotional tension and the rest. The solution is not made easier by the fact that the labour pattern of the different clinical types often merge one with the other. This might help to explain why some schools of thought hold such contrary views to others on whether or not the incoordinate uterus is in a state of hypertonus. Until such fundamental matters are agreed, progress is bound to be slow.

Parity. The vast majority of cases of abnormal uterine action are found in primigravidæ; 96 per cent being the figure in one series of cases. Whether it is due to unconditioned neuromuscular response or to emotional disturbances is not known, but probably the former has the more important place; it is not common for the unfavourable action in the first labour to be repeated in subsequent labours as long as the first labour has either ended in vaginal delivery or at least dilated the cervix well. The resistance to dilatation is great in a first pregnancy, and in the presence of any obstruction—even if this is only relative—disordered action may occur.

Age. This is not nearly so important as it used to be thought, for although abnormal action is assuredly found more often in the elderly than in the young primigravida, it does occur at any age.

Maturity. One of the reasons why concern is felt by some when pregnancy goes much beyond term is that labour tends to be difficult; not necessarily due to disproportion. One view is that the cause of the difficulty exists before labour begins, and is, in fact, the real reason why labour is deferred. Lack of coordination in uterine action and failure in formation of the lower segment is felt to be the fundamental defect.

Uterine over-distension due to twins or hydramnios, has received exaggerated importance in the past, for neither clinical observation nor instrumental recordings of the uterus in labour confirm the existence of weak action under these conditions. Nor do *fibroids* have any influence on function.

Psychological influence. Experience shows that it is almost impossible to predict the particular pattern labour will take in any woman in her first labour. Even the most composed and emotionally well balanced patient may have the worst possible form of disorderly uterine action; and the reverse is true, the abnormally anxious, immature and unrelaxed patient going through the smoothest of labours. It may be that when the emotions are given complete freedom of expression they have less tendency to cause

tension which results in incoordinate uterine action than in those women who inhibit their feelings. The sponsors of natural childbirth and psycho-prophylaxis declare that it is this fear which causes troublesome tension and hence pain and delay. Statistics, however, do not give support to this thesis for there is no significant reduction in the incidence of delayed labour in those patients who have practised relaxation exercises and have gone to instruction classes in pregnancy, over those who have done neither. This is emphasized by the results of labour in unmarried women in whom there is often neither antenatal preparation for labour nor a feeling of social security.

Developmental defects. When fusion of the Mullerian ducts has been incomplete and more especially when development has been unequal leading to asymmetry, as in uterus unicornis, uterine dysfunction is more apt to occur. A defect in the musculature leading to hernia-like sacculation in labour has occasionally been found in patients undergoing Cæsarean section for abnormal uterine action.

Disproportion and malpresentation. An ill-fitting or high presenting part at term has been known for a long time to have a close association with inefficient uterine action. The failure of many a trial labour for dispropor-tion has often been due to this factor; in fact as greater experience of trial labour is gained, it is soon realized that generally it is more a test of uterine function than of the fit of the head into the pelvis.

In breech labour too the breech with extended legs fits the lower seg-ment well and behaves like a well flexed head in promoting normal labour. The same cannot be said for the fully flexed or footling breech which is by no means well-fitting.

When the fœtus lies transversely or obliquely, although the membranes may rupture early, it is common for the onset of labour itself to be greatly delayed. An occipito-posterior position of the head which tends to favour deflexion and a less well-applied presenting part is renowned for its particular type of ineffective and uncomfortable contractions, known as 'posterior position pains'.

One important result of the behaviour of the uterus in cases of malposi-tion is to emphasize the need for very careful examination of the patient whenever uterine action appear to be abnormal. It is well also to remember that too big a baby will often produce the same type of labour.

(1) Abnormally weak action (normal spread of contraction wave)

(i) Primary uterine inertia. The patient is frequently a primigravida, although the same pattern of uterine action is sometimes seen in the case of a patient who has had several pregnancies. The contractions are weak, short lived and infrequent—a faint shadow of normal labour. The

uterine pattern of action and polarity is normal, the only abnorn
being weakness. It usually affects labour from the start (hence the t.
primary) and may last throughout; but often, unless there has been pre
mature rupture of the membranes, the character of the contractions
improves when the waters break. Often too, contractions become normal
only in the second and third stages. Progress naturally is in keeping with the
strength of labour, so is bound to be slow. The condition of the patient
physically is usually good as the pain is minimal, but her morale may
deteriorate unless active efforts are made to support it. As long as the
membranes are intact there is little danger to patient or fœtus.

(ii) Secondary uterine inertia (uterine exhaustion). This is becoming
an uncommon condition because abnormal labour is now better managed.
It is essentially uterine exhaustion or uterine muscle fatigue and, as the
name implies, usually follows prolonged or excessively strong uterine action
in the second stage of labour. It may thus reveal itself during the second
stage or become apparent only during the third stage. It is said that a
diet deficient in first class protein tends to favour this type of inadequate
uterine function but there is no factual evidence for this statement.
Almost always there has been excessive action of one or other form pre-
ceding it.

Deep or prolonged anæsthesia will also cause uterine inertia. Ether has
this effect but chloroform and halothane are even more potent in inhibiting
uterine action.

Clinically the condition is impending if the second stage contractions are
beginning to grow weaker, especially when it has been allowed to last too
long or there has been lack of progress in spite of strong pains. A timely
assisted delivery when this change is first noticed will avoid the appearance
of the fully established condition.

Complete uterine exhaustion is present when the second stage contrac-
tions have finally disappeared and labour is at a standstill. Many cases of
obstructed labour especially in primigravidæ behave like this, with alter-
nating periods of excessive activity and rest before rupture of the uterus or
aided delivery takes place.

In the third stage the completely flabby, inexcitable state of the uterus
is characteristic, and will give rise to delay in separation and expulsion of
the placenta or to postpartum hæmorrhage from partial placental separa-
tion and a failure of uterine retraction.

(2) Abnormally strong action (normal spread of contraction wave)

(i) No obstruction—precipitate labour. When the uterine contractions
are very strong and follow one another rapidly, labour may be completed

quickly, perhaps in a few minutes, and is then known as precipitate labour. The pattern of contractions is essentially normal, the only abnormal feature being their strength. This usually occurs in parous women, in whom the cervix dilates more easily, and resistance of the pelvic floor is slight. It is probable that in many of these cases dilatation of the cervix has been completed practically without any pain before the apparent onset of labour, and then a few strong second stage contractions complete the delivery. Once a patient has had a precipitate labour, even quicker deliveries are liable to occur in subsequent labours.

Apart from the mental upset of a very rapid labour which may catch the patient unawares, the main danger to the mother is from lacerations of the perineum and cervix. The child may be damaged by being born before the mother can lie down, and may sustain injuries to the head, or the umbilical cord may be torn across and cause hæmorrhage.

(ii) Obstructed labour—exaggerated upper and lower segment responses—Bandl's ring. Here again the uterine action is basically normal as regards the pattern of contractions. The upper segment actively contracts and retracts while the lower segment is relatively passive, but because there is obstruction to the passage of the fœtus, the uterus in this case accepts the challenge and responds with powerful action. Because it is the normal task of the upper segment to expel the child and for the lower segment to receive and give passage to it, these particular characteristics appear in exaggerated form when there is obstruction. The upper segment, contracting almost incessantly and retracting, becomes hard and its walls become very much thicker and shorter as it forces the fœtus down and draws the lower segment and cervix up. As time goes on more and more of the fœtus is driven down into the relaxing lower segment which, because of distension, becomes dangerously thin and will rupture if urgent help is not given. The clinical picture is one of a woman exhausted by pain and the demands of the overworking uterus. Her pulse-rate and temperature are raised and the upper part of the uterus is hard and the lower part tender and distended. The line of junction between the two areas denoting the upper and lower segments is clearly visible on the abdominal wall as an oblique groove or furrow. This is the retraction ring, which is present in every normal labour, but which is exaggerated in this case because of the over-thickening of the upper segment and overthinning of the lower. When present in this exaggerated degree it is known as a pathological retraction ring or Bandl's ring. The more the lower segment is stretched the higher the ring will rise. As the fundus rises, the round ligaments become taut and stand out especially to palpation. It must not be thought that this picture of advanced obstructed labour should ever be awaited before help is given —assistance is needed long before.

(3) Disorderly uterine action (abnormal pattern of contraction wave)

(i) **Incoordinate uterine action.** In this condition the uterine function is grossly deranged. There is an increase in muscle tone (hypertonia) especially in the lower segment, even at rest between contractions, and this keeps the intra-uterine tension continuously raised. The raised tension may be above the level of pain production, so that either the patient has continuous pain or discomfort, or it will appear earlier than usual with a contraction and stay longer. This is not the only disadvantage; the raised intra-uterine pressure will, in the,long run, bring about gradually increasing anoxia of the fœtus whose signs of distress may call for urgent treatment by Cæsarean section in the first stage or by forceps delivery in the second.

(a) *Hypertonic lower uterine segment.* The increased tone in the lower segment in this condition brings about a reversal of uterine action; a weakly acting upper segment with a lower segment whose persistent hypertonus completely opposes it. Under such adverse conditions progress, if it is made at all, is distressingly slow. The increased tension makes the labour one of constant discomfort, the pain being felt chiefly in the back. It is this particular type of abnormal action which is often associated with a badly deflexed occipito-posterior position of the vertex, giving rise to so-called 'posterior position pains'. The disturbed uterine reflexes 'and the long labour are often accompanied by intestinal atony (ileus). Abdominal distension and vomiting occur and call for constant attention to electrolyte balance.

(b) *Localized tonic contraction (contraction ring).* This is an uncommon condition. Normal polarity is absent; the intra-uterine tension is raised and contractions painful and purposeless. The term contraction ring dystocia means that an encircling band of muscle fibres is in a state of constant spasm which causes difficulty through narrowing the uterus to such a degree that obstruction occurs. It may become evident in any of the stages of labour; it is associated with a long painful first stage and in the second and third stages it causes delay. Theoretically the ring may arise in any part of the uterus, but is most commonly found at or near the site of the physiological retraction ring at the junction of upper and lower segments, or just above the internal os.

The diagnosis is made on clinical grounds for the contraction cannot be felt or seen abdominally; unless the cervix is sufficiently dilated to allow intra-uterine palpation, a contraction ring in the first stage cannot be diagnosed by vaginal examination. Precise diagnosis is, therefore, usually impossible and the clinical picture is not very different from that of other forms of disorderly uterine action. When it has been possible to locate the site of the ring, either at Cæsarean section or by internal palpation, it has been found most commonly as a constriction round the neck of the fœtus

although on occasions it has been found entirely below the head. Characteristically, it seems to form in the region of a natural groove of the fœtus. Quite unlike Bandl's ring, which appears in an exaggeration of normal labour due to obstruction and heralds uterine rupture, contraction ring results from grossly abnormal action which is seldom effective enough to cause the cervix to dilate and never enough to cause rupture of the uterus.
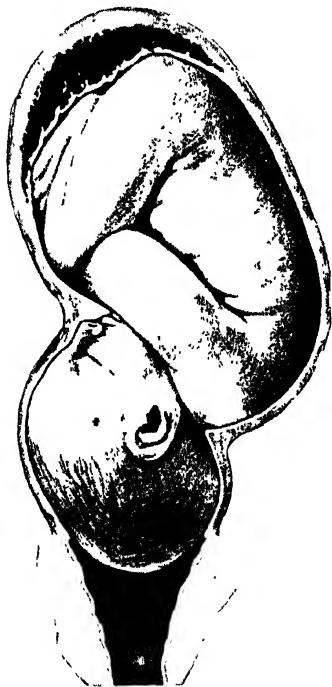
FIG. 89. The contraction ring.

The fœtus is closely embraced by the uterus round the neck, where it is gripped by a constricting band. There is not any thinning of the lower uterine segment.
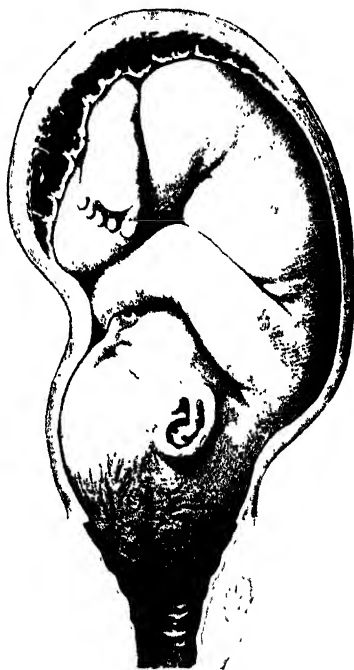
FIG. 90. Generalized tonic contraction.

The uterus as a whole closely embraces the fœtus, but the lower uterine segment does not show thinning.

(c) *Generalized tonic contraction.* This condition is very rare now that the grossly unskilful and repeated attempts at delivery which in the past commonly caused it are so seldom encountered. The action is abnormal in that the whole uterus, both upper and lower segments, are in a state of sustained and powerful hypertonus and the uterus moulds itself to the fœtus.

Usually there have been repeated unsuccessful attempts at delivery—attempts to apply forceps before full dilatation, application of forceps outside the cervix, many attempts to rotate an occipito-posterior position

or repeated attempts at internal version. The patient is exhausted both from these procedures and from the subsequent persistent pain of the tonically contracted uterus. The membranes have usually been ruptured for some time and the fœtus is nearly always dead from anoxia resulting from sustained uterine contraction. There is no danger of uterine rupture from this type of action because the lower segment is hypertonic too, and as the fœtus is dead urgent delivery is seldom called for. This condition of 'active retention of the fœtus' is fortunately extremely rare today.

(ii) **Cervical rigidity.** Only a few of the cases of cervical dystocia should strictly be placed in the category of disorderly uterine action, but for convenience all the varieties are considered here. They may be primary or secondary.

By primary cervical rigidity is meant that the internal os is unyielding through some anatomical or physiological defect, and because it does not relax together with the lower segment it can be regarded as acting in a disorderly fashion.

The patient is most commonly a primipara and is not necessarily elderly. The first stage is prolonged, but the outstanding feature is the condition of the cervix. It is well taken up and closely applied to the engaged head, but it has an excessively firm rim and is unyielding, sometimes admitting no more than a finger-tip after many hours of labour. The lower segment is well formed, and if only the cervix would dilate delivery would proceed. It is in this type of labour that very occasionally a ring of cervix separates by necrosis from continuous pressure of the head.

Secondary cervical rigidity is caused by organic changes in the cervix, either fibrosis due to some previous obstetric injury or gynæcological operation or, rarely, due to carcinoma.

The patient is usually parous and contractions are commonly of good quality. The firm unyielding cervix, because of scarring, may split if timely assistance is not given and the tear may extend into the lower segment. It is for this reason that any patient who has had a previous operation on the cervix should be in hospital for any subsequent delivery.

MANAGEMENT OF PROLONGED LABOUR

In the management of prolonged labour there are a number of basic principles, no matter what is the particular type of abnormal uterine action.

Nursing. The patient should be made as comfortable as possible. If the uterine action is weak she should be permitted to leave her bed in order to stimulate better uterine action. A fluid balance chart should be kept as well as temperature and pulse-rate records. The blood pressure should be recorded at least 4-hourly, but more frequently in the presence of pre-

eclamptic toxæmia. The urine should be tested at least 6-hourly for ketone bodies. The fœtal heart-rate and rhythm are recorded ½-hourly in the first stage when the contractions are strong, or more often if changes have been noted. During the second stage recordings are made at 15 minute intervals. When the membranes rupture the fœtal heart-rate should again be counted and the liquor amnii observed to see if it is stained with meconium.

The frequency, duration and character of the uterine contractions should be charted, and notes should be kept of the physical and mental state of the patient.

Diet. Patients in labour, even in normal labour, should never be given solid food, because if an anæsthetic is needed it is less easy to empty the stomach of solid food than of fluid. When labour is prolonged the patient is all the more likely to require an anæsthetic and the risk of giving solid food is so much the greater. Fluid should be given frequently in small quantities from a measured container. The nature of the fluids will vary, but fruit-juice, beef-tea, milk, soda-water and cups of tea are commonly used Glucose is valuable in preventing ketosis in labour but it should not be given in concentrated solution, as such a solution is highly irritant if it is accidentally inhaled into the lungs. Whenever a patient has been in labour 24 hours without much progress, the whole situation is carefully reviewed, including the patient's general condition and state of hydration. If these are satisfactory no additional measures may be necessary; but if, as so often happens in disorderly uterine action, ileus is beginning with gastro-intestinal distension and vomiting, her fluid, food and electrolyte requirements are much better given intravenously and a Ryle's tube retained in the stomach for repeated gastric aspiration. The intravenous route may also be used for giving antibiotics and in carefully selected cases, oxytocin and pethidine.

Fluid and electrolyte requirements. The average adult needs 2 litres of water and 5 gm. of sodium chloride every 24 hours for her basic requirements, but in hot weather and with a restless patient another ½ litre is needed making a total of 2½ litres. The amount of fluid lost through vomiting or gastric aspiration would need to be added. Basic needs are met in an otherwise uncomplicated case by giving 4 per cent glucose in 1/5 normal strength saline. In serious cases changes in the serum electrolyte concentrations occur, but single observations in labour are of little value unless they are related to the intake and output charts.

Sedative drugs. It is essential to give adequate quantities of sedative drugs in prolonged labour, especially in that due to disorderly action. Usually far too small amounts are prescribed in the mistaken belief that they will make the ineffective action even less effective; in fact the reverse is more commonly the case. In hypotonic inertia a hypnotic such as pentobarbitone (Nembutal) 200 mg. (3 gr.) is indicated at night, but in cases of

painful disorderly action one of the pain relieving analgesics is required. Morphia 15 mg. (¼ gr.) and hyoscine 0·4 mg. (₁₅₀ gr.), or pethidine 100 mg. and hyoscine 0·4 mg. (₁₅₀ gr.) are usually very effective in giving suitable rest; it is important for the analgesics to be given at night, unless delivery is imminent. It there is doubt about the speed of progress it would be safer to give morphia or pethidine, for then the inhibitory effect of both can be counteracted either by giving the mother 10 mg. of nalorphine intravenously 10 to 15 minutes before delivery. Nalorphine given in greater dosage, or when not used to counteract morphia or pethidine depresses respiration. Pethilorfan, which contains both pethidine and nalorphine, can be used instead.

When less powerful analgesic action is needed a combination such as pethidine and promazine hydrochloride (Spareine) 50 mg. repeated 4 to 6 hourly, not uncommonly has an accelerating effect on the labour by reducing spasm and relieving pain. Continuous intravenous pethidine (300 mg. in 1 litre of 5 per cent glucose saline) can be used very effectively in hypertonic states to control pain and at the same time to adjust fluid and electrolyte levels.

Continuous caudal or epidural analgesia has been used with a good deal of success in disorderly uterine action. As would be expected pain is completely relieved; in a high percentage of cases the tension and spasm in and around the lower segment and cervix are reduced to such an extent that the second stage of labour is often reached within 4 to 6 hours after the injection. The method is to inject 20 ml. of lignocaine (xylocaine) up the caudal canal using an indwelling malleable needle. Further injections of 15 ml. are given at ½-hourly intervals. The chief disadvantage of the caudal route is occasional difficulty in inserting the needle. It is only suitable for institutional midwifery.

The analgesics mentioned so far, with the exception of caudal analgesia, only apply to the first stage of labour. Control of pain in the second stage following a prolonged first stage is met by giving the usual inhalation anæsthetics.

Antibiotics. In prolonged labour if there is evidence either from the temperature chart, or from the character of the escaping liquor, or from an unexpected and sustained rise in the fœtal heart-rate that genital infection has taken place, antibiotic therapy and chemotherapy should be begun immediately. A high vaginal swab for organisms and sensitivity is taken and, whilst awaiting the report, penicillin and streptomycin therapy is begun. Even without frank evidence of infection it is now standard practice to start antibacterial therapy after any labour has lasted 48 hours and it is especially important if the membranes have ruptured. It is done not only for the sake of the patient, but also to prevent infection of the fœtus *in utero.* When there are signs that intra-uterine infection has taken place, no time

should be lost in delivering the patient even by Cæsarean section under full antibiotic cover if vaginal delivery is considered unsafe.

Preparation for anæsthesia. It is of great importance to pass a tube and aspirate the stomach before an anæsthetic is given, because of the association of ileus with prolonged labour. The anæsthetist must be prepared to deal with vomiting by the patient, and either pass a cupped intra-tracheal tube or have suction apparatus ready, together with some means of lowering the patient's head quickly.

If only fluids have been given by mouth a narrow bore Ryle's tube passed *via* the nose will suffice and will not be too upsetting. If solids have been given within the preceding 8 hours a wide-bore tube must be used, or apomorphine given to promote vomiting, because the stomach empties slowly in labour. It is preferable to correct fluid and electrolyte balance before giving an anæsthetic.

SPECIAL MANAGEMENT

Primary uterine inertia. This diagnosis calls for a most careful examination of the patient to make sure that there is no unsuspected disproportion. The baby is not uncommonly very large and inertia may be associated with an occipito-posterior position of the head.

When there is no doubt that slow labour is due to hypotonic uterine action without any factor of mechanical obstruction it is worth considering the use of continuous intravenous oxytocin.

Intravenous oxytocin. The method is suitable only for institutional midwifery and would only be used under the guidance of someone of experience.

Two and a half units of oxytocin (pitocin or syntocin) are thoroughly mixed in a bottle (540 ml.) of 5 per cent glucose solution. The intravenous drip is begun with 40 drops a minute and the response observed over the next 30 minutes. The fœtal heart rate is carefully counted and is recorded on a chart at intervals of not more than 15 minutes, and the frequency and strength of the uterine contractions are also observed and recorded. In the large majority of cases the quality of action improves greatly and satisfactory progress is now made. If the uterine contractions are unduly frequent or prolonged the drip should be run more slowly, and stopped at once if the fœtal heart-rate shows a persistent rise or fall. Conversely, the rate of the infusion can be increased if there is no response. It is usual to keep the drip running until the third stage is over, although the rate can be reduced if necessary.

Forceps delivery or delivery with the ventouse. When a patient reaches the second stage after a tediously long first stage, she is often too tired to push; it is then fully justifiable to aid delivery with forceps without further delay

as long as the usual conditions are fulfilled. If fœtal distress arises when the cervix is not quite fully dilated, dilatation can be completed by pushing the cervix up with the hand and delivering the child with the forceps. As an alternative the ventouse (vacuum extractor) can be used (see p. 524).

Secondary uterine inertia (uterine exhaustion). If uterine activity ceases in the second stage because of muscle fatigue the patient requires an assisted delivery. An oxytocin drip should be set up, the patient anæsthetized and the child delivered with the forceps. Because in this case two predisposing factors to post-partum hæmorrhage are present, anæsthesia and uterine fatigue, it is advisable to have blood ready for transfusion and to give 0·5 mg. ergometrine intravenously when the anterior shoulder has been delivered. As soon as the uterus contracts the placenta is immediately delivered by Brandt-Andrews' method (see p. 152). The treatment of post-partum hæmorrhage is described on page 469, and should be applied at once if there is any abnormal loss.

Precipitate labour. If the labour is really precipitate there is no treatment as it occurs in the absence of a doctor or midwife; all that can be done is to keep the patient lying down. The lower genital tract should be carefully examined for injuries at a suitable opportunity. When medical aid is available an anæsthetic, such as ether or chloroform, should be given to diminish the intensity and frequency of the contractions, and an episiotomy may be needed to avoid a third degree perineal tear.

A patient who has had a precipitate delivery is likely to repeat this in subsequent labours. She should be admitted to hospital near term and the membranes may be ruptured to ensure that delivery takes place under controlled conditions.

Obstructed labour. This condition should never be allowed to develop for it represents negligent or unskilled management. The predisposing causes of obstructed labour should be obvious early in labour with careful supervision. When it develops during labour, e.g. when the head becomes extended to a brow presentation, the fact that the presenting part has become arrested in spite of strong contractions should be obvious long before the late signs of obstructed labour develop.

Once it has appeared urgent help is needed because at any moment the uterus may rupture. Two things have to be done quickly. The first is to anæsthetize the patient to inhibit the powerfully retracting upper segment. With an expert anæsthetist fluothane or chloroform may be used, otherwise ether. The second is to deliver the child quickly, though as carefully, as possible. The fœtus is usually dead, but this does not mean that embryotomy is the safest method of treatment. Whilst decapitation can often be

done safely in a shoulder presentation, it is far too late and too dangerous to consider internal version. Cæsarean section today with effective antibiotic cover is usually the safest means of delivery in advanced obstructed labour, even when the fœtus is dead. If the fœtus is still alive Cæsarean section is always indicated.

Inco-ordinate uterine action can only be treated symptomatically because effective drugs which act selectively on the lower uterine segment and reduce its tone have not been discovered. The diagnosis is often uncertain, and in many cases there are additional factors of disproportion or malposition of the head. What has been said about the general management of prolonged labour applies particularly to disorderly uterine action. The emphasis is on the relief of pain and lowering of hypertonus; to this end full consideration should be given to the use of continuous intravenous pethidine and to continuous caudal analgesia.

Cæsarean section still plays a big part in the treatment and it should be resorted to as soon as conservative measures have failed. It is at present the only answer when progress has ceased in the first stage and the cervix is not sufficiently dilated for manual dilatation and forceps delivery.

Contraction ring dystocia. A contraction ring in the first stage is managed like any other form of disorderly action. Rarely it forms below the head when it may be possible to feel it through the cervix. Cæsarean section is indicated. A contraction ring in the second stage of labour is most commonly found unexpectedly, usually after forceps have been applied and traction has unaccountably failed. By palpating above the head in the region of the neck the contraction will be felt. Success sometimes follows the administration of amyl nitrite by inhalation under an anæsthetic mask; because the action is only short-lived, the forceps should already be in position and the operator ready to apply traction when the drug is given.

Deep anæsthesia is usually sufficient to allow the hand to pass through a contraction ring in the third stage of labour, although amyl nitrite may be used in addition.

Cervical dystocia. In the primary forms this condition is treated like any other form of disorderly uterine action. Cæsarean section is commonly needed but if the cervix is nearly fully dilated then manual dilatation, or incision, might be considered under the same conditions as those already mentioned.

Secondary cervical dystocia is found more commonly in multiparæ and so the contractions are often of normal strength and character. If dilatation is not progressing steadily under these conditions Cæsarean section should be decided on quickly before the scarred cervix has a chance of splitting, possibly into the lower segment.

EXCEPTIONAL VAGINAL PROCEDURES

If labour reaches the second stage the child should be delivered with the forceps without delay to save further stress to an already tired patient and anoxic fœtus.

Progress may cease before full dilatation is quite reached. The cervix can be manually dilated if conditions permit. For it to be safe the head must be well down in the pelvis and in an anterior position, the cervix thin and at least three parts dilated; the operation must be carried out in hospital. One of the chief dangers is laceration of the cervix; the tear may extend upwards and involve a large vessel with consequent hæmorrhage.

Cervical incision is occasionally indicated in similar circumstances, the cuts being made bilaterally. The same skill, judgement and risks as with manual dilatation again operate. Both procedures must be followed by forceps delivery and the cervix immediately inspected and repaired.

Another possibility is to apply the ventouse (vacuum extractor) to the fœtal head and to apply gentle intermittent traction, but if the extractor is left in place for more than 40 minutes there is some risk of causing necrosis of the of the scalp.

On the whole Cæsarean section is preferable to any vaginal operation unless the cervix is fully, or nearly fully, dilated.

OBSTRUCTED LABOUR

THE term 'obstructed labour' has largely been displaced by the word *dystocia* which means difficult labour. This condition may be considered under the headings given below. The reader can best appreciate the variety and number of conditions which can produce obstructed labour from the following table, but it is most important to note and to understand at this stage the fact that obstructed labour is not inevitable in the case of any that are listed.

1. *Maternal Conditions which may cause dystocia.*
    (*a*) Contraction or deformity of the bony pelvis (common).
    (*b*) Tumours of uterus or ovary (occasionally).
    (*c*) Tumours of rectum or bladder (rare).
    (*d*) Tumours of pelvic bones (rare).
    (*e*) Pelvic kidney (rare).
    (*f*) ·Stenosis of cervix or vagina (rare).
    (*g*) Congenital septum of vagina (rare).
    (*h*) Contraction ring of uterus (rare).
    (*i*) Sacculation of uterus (very rare).
In addition the importance of general rigidity of the soft tissues of the birth canal is now more fully appreciated. The lack of such resistance in multiparous patients explains the frequency of easy confinements in them even in the presence of mild disproportion.

2. *Fœtal Conditions which may cause dystocia.*
    (*a*) Malposition of the fœtus.
        (i) Persistent posterior position of the occiput (very common).
        (ii) Deep transverse arrest of the fœtal head (very common).
    (*b*) Malrepresentation of the fœtus.
        (i) Breech presentation (occasionally).
        (ii) Face presentation (occasionally).
        (iii) Brow presentation (occasionally).
        (iv) Shoulder presentation (common in countries in which there is inadequate antenatal care).
        (v) Compound presentation (rare).
        (vi) Locked twins (very rare).
    (*c*) Congenital abnormalities of the fœtus.
        (i) Large fœtus (common).
        (ii) Hydrocephalus (rare).

  (iii) Iniencephalus (rare).
  (iv) Hydrops fœtalis (uncommon).
  *(v) Fœtal abdominal tumours or ascites (rare).
  (vi) Double monsters (very rare).

Definition. Labour is said to be obstructed when there is absence of progress in the presence of strong uterine contractions. Such absence of progress may be shown in failure of the cervix to dilate or failure of the presenting part to descend the birth canal.

Prophylaxis and diagnosis. Antenatal care has done much to lessen the incidence of obstructed labour. The cause may be detected during pregnancy in many of the cases and this will facilitate early treatment of the cause or lead to consideration of a plan of action for the conduct of the subsequent delivery. Many of these conditions are described fully in their appropriate chapters and there follows only a brief review in which an attempt is made to help the reader view this important condition in its correct perspective.

Obstruction in labour is always relative. In the presence of poor contractions of the uterus, or, in the second stage of labour, of poor expulsive efforts, a minor abnormality may produce serious obstruction. In contrast, if the uterine contractions are strong and are efficient in their action they may overcome, often with remarkable ease, what would appear to have been an almost inevitable cause of obstruction. Dystocia may have been present in a first labour, and may be observed not to exist in the second or subsequent confinement even when the cause is known to be a minor degree of contraction of the pelvis.

Contracted pelvis. When the upper part of the pelvis is contracted the fœtal head will fail to engage near term. If there have been previous labours these may have terminated in difficult forceps extraction or Cæsarean section. The rare condition of contraction of the outlet must be recognized by pelvic examination before labour.

Bimanual examination with two fingers in the vagina permits a clinical assessment of the pelvis and doubtful cases will require a full radiological pelvimetry (see p. 421). Gross disproportion is treated by elective Cæsarean section before the onset of labour, whereas lesser degrees of disproportion are submitted to trial of labour (see p. 429).

Fibromyomata of the lower uterine segment may seem likely to obstruct labour, but as the lower segment develops such fibroids are not infrequently drawn up above the presenting part. Fibroids of the cervix may cause persistent obstruction as they do not rise up, and will necessitate Cæsarean section.

Ovarian tumours are best detected early in pregnancy and removed at about the 16th week. Those discovered after this time may still be removed during pregnancy, but when a tumour is only found in the last

month it may be left for removal in the puerperium, provided that it can be pushed up above the presenting part to allow vaginal delivery. Early removal in the puerperium is recommended as there is a risk of torsion.

If a tumour remains in the pelvis under no circumstances should an attempt be made forcibly to extract the fœtal head past it. This may cause rupture or dissemination of the tumour, maternal shock and a risk of fœtal death from intracranial hæmorrhage. If the tumour cannot be pushed up out of the pelvis Cæsarean section is indicated, and the tumour is then treated on its merits.

Constriction of the cervix or vagina may be congenital, or may be due to fibrosis following trauma and infection. Scarring of the cervix from previous laceration, or after amputation of the cervix, occasionally offers great resistance to dilatation. Atresia of the vagina, sufficient to delay or prevent the birth of the child, may be congenital, or may result from vaginitis, or from plastic operations for prolapse. Delivery *per vaginam* is fraught with the danger of severe laceration and the possible production of a vesico-vaginal or recto-vaginal fistula. The treatment is Cæsarean section.

A congenital septum of the vagina may cause obstruction during the second stage of labour. Under general anæsthesia the septum is divided and the cut edges are oversewn after delivery if bleeding occurs.

Contraction ring of the uterine muscle has been described in the preceding chapter. It may not only occur in cases of undiagnosed, and therefore neglected, cases of obstructed labour, but may result from unskilled and ineffective efforts to assist delivery. It often provides an insuperable obstacle to delivery but occasionally inhalation of amyl nitrite under deep general anæsthesia may effect relaxation and permit vaginal delivery with forceps.

Malpositions of the fœtal head may require correction under anæsthesia during the second stage of labour. When labour is prolonged the applications of a Malmström vacuum extractor before full dilatation of the cervix may encourage rotation and hasten delivery in carefully selected cases with adequate pelves.

Breech and shoulder presentations may be eliminated by external cephalic version performed after the 32nd week of pregnancy. Face, brow or compound presentations within the pelvic cavity may require correction before vaginal delivery, but if these malpresentations persist above the pelvic brim they are best treated by Cæsarean section.

A large fœtus may be due to a familial tendency, or may be associated with maternal diabetes or the pre-diabetic state. The head is large and well ossified. Assessment in pregnancy, even with the assistance of X-rays, is often difficult. A lateral radiograph taken during labour may provide valuable information about the degree of moulding and descent of the head.

Hydrocephalus may be recognized in pregnancy and can be confirmed by radiography and palpation through the cervix of the widely separated cranial bones. A cephalic presentation is preferable since the head can be perforated and the obstruction overcome when the cervix is only 3 cm. dilated. Mild cases of hydrocephalus, meningocele and encephalocele may not cause obstruction.

Iniencephaly is a congenital abnormality in which the head is hyper-extended and the soft tissues over the occiput and sacrum are fused. It is diagnosed radiographically. Induction before the 32nd week may avoid the need for Cæsarean section.   ‹

Gross *hydrops fœtalis, fœtal ascites or tumours of the fœtal abdomen* may rarely cause obstruction and necessitate evisceration.

Occasionally in multiparous women the abdominal walls are so lax as not to form any support to the enlarging uterus during the last few weeks of pregnancy. The laxity may be so pronounced and the devarication of the muscles so marked that the unsupported uterus falls forwards with its axis pointing backwards. This, together with non-engagement of the fœtal head may provide a cause for dystocia. The provision of an efficient binder to support the uterus may help these women.

Emphasis has already been given to the importance, especially in what may be termed minor causes of dystocia or obstructed labour, of the strength and efficiency of the uterine contractions. Mention was then made of the fact that dystocia in a first labour may not be followed by dystocia in a second or subsequent confinement owing to a greater degree of efficiency in the process of labour. However, if the woman has borne many children dystocia may, and probably will, reappear for two reasons. Her uterine musculature seems gradually to become enfeebled with repeated child-bearing and there is a tendency for a progressive increase in the size of succeeding babies.

Symptoms and signs of obstructed labour

The importance of the early detection of possible obstruction in labour is obvious, for if labour is allowed to progress to the point of absolute obstruction the death of the fœtus is almost certain and the life of the mother is endangered. A careful watch is always kept on the general condition of every woman during labour and probably the earliest sign of impending obstruction is a deterioration in the woman's general condition. The patient looks tired and for the first time behaves as though she is beginning to lose her ability and will to co-operate. A competent nurse will often detect these changes and may report that the frequency and strength of the contractions are diminishing. If neglected this patient will enter a stage of exhaustion both in herself and in her uterus, but given rest the

relief is only temporary, for obstruction will not be overcome in the interval. Between the pains the woman seems unable to relax and her anxiety increases.

In the primigravida complete obstruction leads within two or three days to a state of uterine exhaustion or 'secondary uterine inertia', which may give some (only temporary) relief to the mother and fœtus. In the multigravida, however, obstruction becomes established much sooner and progressive thinning of the lower segment may lead to uterine rupture within 24 hours.

The presenting part is often above or at the level of the pelvic brim. The membranes usually rupture early in labour because the presenting part is badly applied to the lower segment, and early invasion of the uterine cavity by pathogenic micro-organisms will occur. As the cervix dilates it hangs like a curtain below the fœtal head, to which it is badly applied. The liquor drains away and there is retraction of the placental site, reduction in placental blood flow and eventually fœtal death from anoxia. In late obstruction a rise occurs in the patient's temperature and a steady and decided rise in her pulse and respiration rates. The blood-pressure readings also increase. Partly through her inability to take, or to absorb food, her general state becomes further impaired by the onset of ketosis. The quantity of urine secreted diminishes greatly and it is concentrated and deeply coloured. Ketones are present in large amounts and these substances can be smelt in the patient's breath. Œdema is likely to develop and the cessation of secretions is shown in the dry furred tongue and the absence of mucous secretion from the cervix and of the vaginal transudate. The last signs that have been described must be regarded as terminal. As has been stated, early diagnosis and the taking of appropriate steps toward their prevention is usual in every well run obstetric practice or department. The likelihood of obstructed labour should be suspected if at any time the labour fails to progress. Thus in the first stage dilatation of the cervix should be continuous, albeit sometimes it is not rapid. Descent of the presenting part also should be continuous throughout labour and especially so in the second stage. Any failure in the progress of labour demands the most thorough and searching examination and investigation in order to discover a possible cause, or at least to confirm the absence, of a serious complication. If ordinary clinical examinations do not result in definite findings they should be repeated when the patient has been anæsthetized. In cases of suspected disproportion due either to pelvic contraction at any level or to the presence of an abnormally large fœtus, X-ray examination can be most helpful and, if the confinement is being conducted in a hospital, can be made during the labour.

If for some reason the diagnosis of established obstruction has been missed, and this unfortunately may happen even today, a rapid deterioration

in the woman's general state occurs. Certain changes in the uterus must be described which, apart from their important influence on the correct·management of the condition, inevitably cause the death of the fœtus and endanger the life of the mother.

The uterus in obstructed labour

This condition was known as tonic contraction of the uterus, but it is essentially one of over-retraction, and is more correctly called *tonic retraction of the uterus*. It is often slow and insidious in its onset, taking several hours to develop. The first stage of labour may progress normally.
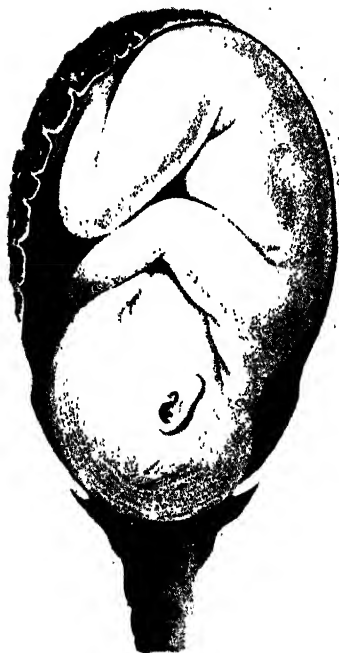
FIG. 91. Diagrammatic representation of normal labour, showing the symmetrical shape of the uterus.

The child is nowhere closely embraced by the uterus and there is room for liquor amnii.
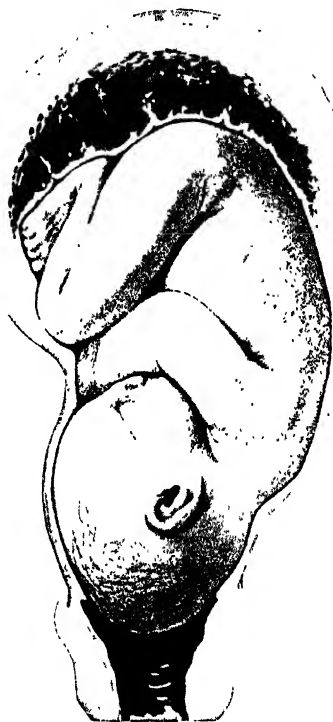
FIG. 92. Tonic retraction of the uterus The upper segment of the uterus is thickened the lower segment thinned. The uterus as whole closely embraces the fœtus.

In the course of normal labour some retraction persists after each contraction, the upper segment beomes slightly thicker and shorter as the

fœtus descends, but the lower segment is not unduly stretched (Fig. 91). If the fœtus is unable to descend, the total length of the uterus must remain constant. In obstructed labour therefore, progressive retraction causes greater thickening of the upper segment, with consequent overstretching and thinning of the lower segment. This is pathological retraction and its occurrence sooner or later must be regarded as inevitable in a case of obstructed labour (Fig. 92). The line of junction of the upper and lower segments is known as the retraction ring of Bandl, which becomes more marked and moves slightly upwards as the condition progresses. Eventually, rupture of the uterus occurs at the junction of the upper and lower segments of the uterus. Death of the fœtus results from compression of the placental-site circulation.

Symptoms and signs of tonic retraction

Labour may progress normally during the first stage, but when the progress of the fœtus becomes obstructed, the uterine contractions usually increase in force and frequency and are often accompanied by strong bearing down efforts. After a time the mother becomes exhausted. She is usually restless and looks drawn and haggard. Pain is severe and continuous. Her tongue and lips become dry and discoloured, the pulse-rate is 140 or over, and the temperature may be raised to 100"F or more.

On abdominal examination, the uterus is found to be moulded to the shape of the fœtus, it is hard all the time, and does not relax, as it normally does, between contractions. The uterus is also very tender on palpation. A transverse ridge, the ring of Bandl, may be seen or felt at the junction of the upper and lower segments. Fœtal parts cannot be clearly felt, and the fœtal heart is not heard because tonic retraction inevitably causes fœtal death. The presenting part is fixed at the level of the obstruction. The obstruction nearly always occurs in the cavity or just below the pelvic brim; it is very rare nowadays for serious obstruction at the pelvic brim not to have been detected during the last weeks of pregnancy. Serious obstruction at the pelvic outlet is uncommon.

On vaginal examination, the vagina and vulva are œdematous, and the birth-canal is hot and dry. The œdematous cervix may be felt below the presenting part. If the head is presenting, there will be a large caput succedaneum and marked moulding of the cranial bones. In the course of time and in a grossly neglected case the presenting part cannot descend. Owing to the repeated retraction of the uterine muscle it becomes tightly fixed. Even under anæsthesia it cannot be pushed upwards without great danger of uterine rupture indicating that impaction has occurred. If the shoulder is presenting, it is impacted and œdematous, the arm may be prolapsed and the hand projecting from the vagina.

Concealed accidental hæmorrhage may bear a superficial resemblance to tonic retraction if the patient is first seen in a condition of shock. The mistake, however, should never be made. In the former condition the patient has never been in labour, whereas in the latter labour has been established for many hours. In concealed accidental hæmcrrhage the uterus is hard and tender, fœtal parts cannot be felt and the fœtal heart is not heard; on vaginal examination there are no signs of impaction, and no cause of obstruction is found. Tonic retraction must not be mistaken for uterine inertia or uterine irritability, in which the uterus does relax, and the presenting part is not impacted.

Rupture of the uterus

Prolonged obstruction in the primigravida usually leads to secondary uterine inertia from complete uterine exhaustion, but in the multigravida obstruction is more likely to lead to uterine rupture. This usually occurs obliquely at the junction of the upper and lower uterine segments, but occasionally the uterus splits vertically through the lateral point of entry of the uterine vessels. The peritoneum may or may not be involved. Bleeding may occur into the peritoneal cavity or may track downwards between the bladder and the upper vagina. Uterine contractions may expel the fœtus and placenta through the laceration into the peritoneal cavity, and on palpation the fœtus and uterus may be felt separately. At the time of rupture there will be an exacerbation of pain and a feeling of something having given way. If the fœtus is expelled the intermittent labour pains will cease and be replaced by a continuous pain from peritoneal irritation, with progressive shock from internal blood loss. The skin is cold, damp and pale. The pulse is fast and feeble, the blood pressure falls and there may be air hunger. On vaginal examination the presenting past may have receded, there will be some blood loss, and occasionally a loop of bowel may be felt. (See also p. 433.)

TREATMENT

1. Prevention of tonic retraction. Tonic retraction should never be allowed to develop, because the cause of the obstruction should have been discovered during pregnancy or early in labour, and appropriate treatment adopted.

2. Treatment of tonic retraction. When tonic retraction has developed, the aim of treatment is to deliver the patient as safely and as quickly as

possible. In every case tonic retraction causes the death of the fœtus. Intra-uterine manipulations are very liable to cause rupture of the thinned lower uterine segment, and are therefore contra-indicated. Version is particularly dangerous, and attempts at forceps delivery will fail. The fœtus is certainly dead and delivery will be effected only after some destructive operation, or by Cæsarean section. Both are hazardous procedures. It is probable that Cæsarean section is the safer method. The improved technique of the lower segment operation, the use of antibiotics, modern methods of anæsthesia and blood-transfusion have all helped to lessen the dangers of this operation. Destructive procedures are usually lengthy, difficult and dangerous.

The patient should be removed to hospital under heavy sedation, such as pethidine 200 mg. Tonic retraction must always be regarded as a grave emergency.

If craniotomy is decided upon, full surgical anæsthesia should be induced and maintained until delivery, which should be completed as quickly as may be compatible with the safety of the mother. In cases of disproportion the head must be perforated, and delivery effected with the craniotomy forceps. With an impacted shoulder presentation, decapitation is necessary, and with fœtal abnormalities some form of embryotomy will be required. With extreme degrees of pelvic contraction or with large pelvic tumours when delivery *per vaginam* is impossible even after craniotomy, Cæsarean section is the only possible method of treatment. It is attended by con-siderable risk if the patient has been long in labour, and particularly if attempts at delivery *per vaginam* have already been made. The operative details of craniotomy are described on page 536.

3. Treatment of rupture of the uterus (see p. 436). Blood transfusion is required, and if there is dehydration and ketosis intravenous glucose saline must be given to render the patient fit for general anæsthesia. The abdomen is opened and fœtus, placenta, liquor and blood are rapidly removed. A small uterine laceration may be repaired and future pregnancies prevented by tubal ligation. More extensive lacerations may demand hysterectomy. Paralytic ileus is anticipated and gastric suction maintained until bowel sounds return. Antibiotics are given to prevent infection.

VERTEX, FACE AND BROW PRESENTATIONS

OCCIPITO-POSTERIOR POSITIONS OF THE VERTEX

THE mechanism of labour in occipito-posterior positions of the vertex has already been referred to in Chapter 13. In most cases in which the occiput lies posteriorly labour progresses normally. This is likely to occur in the first place because the foetal head is sufficiently flexed and, secondly, because the dimensions and shape of the bony pelvis are normal and adequate in the majority of women. With good flexion of the head the occiput, being the first part of the skull to meet the pelvic floor, usually undergoes a long rotation forward through three-eighths of a circle and is thus directed to the open space beneath the pubic arch. In about one-fifth of the cases of posterior position of the occiput this does not occur and the malposition persists. A short rotation of one-eighth of a circle then takes place which results in the occiput being directed backwards to lie in the hollow of the sacrum. Formerly it was believed that this was nearly always due to the poor flexion of the foetal head, which indeed is more likely to accompany the occipito-posterior position. As the result of poor flexion it is possible that the first part of the foetal head to reach the pelvic floor would be the sinciput, and this part of the foetal head would therefore rotate forward through one-eighth of a circle, the occiput perforce having to rotate a corresponding distance backwards. That poor flexion of the foetal head is not the only factor is now certain. The direction of any rotation of the foetal skull, and indeed the outcome of labour, is known to be influenced by the shape of the bony pelvis especially in the dimensions of the cavity and outlet of the pelvis. In the android type of pelvis there is narrowing of the pelvic cavity from side to side and the size of the cavity tends to diminish in the lower straits. The angle of the pubic arch is likely to be acute and the ischial spines to project more into the birth canal. There tends therefore to be less room in the anterior part of the pelvis and the slight deformity of the pelvic shape appears to prevent a complete anterior rotation of the occiput, even in the presence of complete flexion of the foetal skull. It is possible therefore to find persistent posterior position of the occiput with complete flexion of the foetal head. That the shape of the pelvis is sometimes responsible for the persistent occipito-posterior is strongly suggested by the repeated occurrence of this malposition in the subsequent labours of individual women.

Lastly it seems that the long rotation of the occiput forwards through three-eighths of a circle may be interrupted when the projection into the pelvic cavity of the spinous processes of the ischia is more pronounced than usual. Descent of the fœtal head well into the cavity of the pelvis is retarded and flattening of the anterior surface of the sacrum could arrest the rotation of the fœtal head so that it lies transversely, the occiput being to one side of the pelvis and the face to the other. In this position further descent is arrested. The problem is considered at greater length later in this chapter.

<center>DIAGNOSIS</center>

Diagnosis during pregnancy is of little consequence, except that occipito-posterior position must be recognized as a cause of non-engagement of the head before the onset of labour. During labour a lack of flexion of the head may be suggested by early rupture of the membranes. It is also possible that the poorly flexed head is less effective in causing dilatation of the cervix, and it is quite frequently associated with painful spasmodic uterine contractions and prolonged labour.

Serial radiographs taken during labour suggest that the occipito-posterior position of the head may change the uterine axis. Instead of the head being pushed directly down onto the cervix it is pushed downwards and forwards against the back of the symphysis pubis. Thus much of the effectiveness of the uterine contractions is lost and cervical dilatation is slow. The cervix may be compressed between the head and the pubis, so that progressive œdema of the anterior lip of the cervix occurs. For the same reason, before the onset of labour the head may bulge the anterior wall of the lower segment, and the cervix comes to lie relatively posteriorly in the hollow of the sacrum. This will often delay the onset of labour, leading to postmaturity and reduction in the effectiveness of surgical induction.

Abdominal examination. The diagnosis should be made without difficulty by abdominal examination in the interval between uterine contractions. Slight flattening of the abdomen may be observed, and the limbs, being in front, are easily felt. It may be difficult to define the back or to hear the fœtal heart. This should be listened for well to the side of the abdomen, but it may sometimes be best heard near the mid-line. When the latter is the case it is probable that the heart sounds are heard through the chest wall and this may be taken as evidence of the lack of general flexion of the fœtus. The head should descend normally through the pelvic brim as labour progresses, but descent may be slow owing to poor flexion. Failure of the fœtal head to engage in the pelvic brim after the onset of labour should always be regarded as a sign of some possibly serious abnormality.

When the fœtus is in an occipito-posterior position failure of the head to engage may be due to poor flexion of the fœtal head, but it may also be caused by contraction of the brim, as in an android type of pelvis.

Vaginal examination. Early in labour it may be difficult to reach the presenting part, and the bag of membranes may bulge in an elongated manner and rupture early. When the head has entered the pelvic cavity the most striking feature is the ease with which the anterior fontanelle can be felt. This fontanelle is directed forwards and to the left in the right occipito-posterior position, forwards and to the right in the left occipito-posterior position. The anterior fontanelle is more easily felt because the head is less well flexed, and also because this fontanelle lies well forward when the head is in the occipito-posterior position. An attempt should be made to assess the degree of flexion of the head, as the well flexed head rotates more easily. Palpation of the posterior fontanelle indicates full flexion. If the anterior, or if anterior and posterior fontanelles, are felt the fœtal head is poorly flexed.

Although the diagnosis should be made early in labour, it not infrequently happens that the position is unrecognized until there is delay in the second stage of labour. Diagnosis by vaginal examination may then be difficult owing to the formation of a caput succedaneum over the presenting part. The position of the fontanelles and sagittal suture is now of great importance. It may be found that the sagittal suture is lying transversely, the fontanelles being felt on either side; this is known as deep transverse arrest. Or it may be found that the sagittal suture is more or less antero-posterior, with the anterior fontanelle in front: this is known as a persistent occipito-posterior position.

When there is doubt as to the position of the occiput, an attempt should be made to feel an ear, the free border of which points to the occiput. This examination will have to be made under an anæsthetic, which is often necessary in order to discover the reason for delay in the second stage in labour.

The course of labour in occipito-posterior positions

This malposition may cause difficulty in labour. During the last weeks of pregnancy all may seem to be well because the fœtal head is engaged in the pelvic brim. The first sign of trouble, therefore, will not appear until labour has been in progress for many hours, or even until the second stage of labour has been reached. In other cases in which the malposition has been diagnosed, and even in which the non-engagement of the fœtal head has been consistently noted, the subsequent labour may be entirely normal in that the first stage is not prolonged, and the birth of the baby with the occiput anterior is unassisted.

Again, especially in multiparous women, but quite frequently in the birth of a first baby, labour progresses entirely satisfactorily and, often to the surprise of the practitioner or midwife, the baby is born withðut any difficulty, directly occipito-posterior in position or, as it is termed, face to pubes.

Yet another difficulty is that whereas diagnosis of the malposition during pregnancy presents no difficulty, nothing can be done at that time towards its correction. While there is thus no absolute need to suggest that arrangements be made for the confinement to take place in hospital, in this particular malposition it is particularly true that the course of labour is unpredictable and serious delay or even obstruction may occur. Frequently an experienced midwife will come to suspect, from her observations early in the first stage, the probability of delay in labour, and therefore the need for subsequent assistance. She may note that the uterine contractions while painful, are poor in quality or colicky in nature, and may refer to them as 'posterior-position pains'. It is possible that the poor flexion of the fœtal head fails to provide that reflex stimulation of the lower segment which is thought to be produced by the more pointed vertex in the case of full flexion.

A long first stage of labour in itself is likely to be followed by a long second 'stage for the woman is tired and the uterine muscle may be incapable of further strong contractions. Failure of progress in the second stage of labour demands a thorough examination to determine the exact cause of the delay. Assistance can be given to hasten the delivery of the fœtus only after such an examination has been made.

Whether an occipito-posterior position was known to exist at the onset of labour or not, or whether the occiput is thought to have rotated completely or partly forward, or to have remained posterior in position, does not matter. Such delay demands the most careful examination to determine the cause, and in view of the necessity for subsequent assistance the examination is better made after the patient has been anæsthetized. Lastly, repetition is made, and with emphasis, of the statement that it is never possible to forecast in the case of this malposition what will happen in labour and that the baby may be born, as has been stated already, without difficulty face to pubes.

Moulding of the head in occipito-posterior positions

A knowledge of the moulding of the fœtal skull is of practical importance as it affects the making of the diagnosis, and influences the nature of assistance when this is necessary.

When the fœtal head descends into and down the birth canal and flexion of the head is poor the skull will be compressed in the occipito-frontal

diameter. This change in the shape of the fœtal head is shown in Fig. 93. Often, for instance if the fœtus is of normal size or not unduly small, or alternatively if the mother's pelvis is not large or even slightly contracted, the moulding will be most pronounced. If the change in shape is brought about fairly rapidly as the result of strong and frequent contractions of the uterus, the structures in the skull are unlikely to be able to adapt themselves
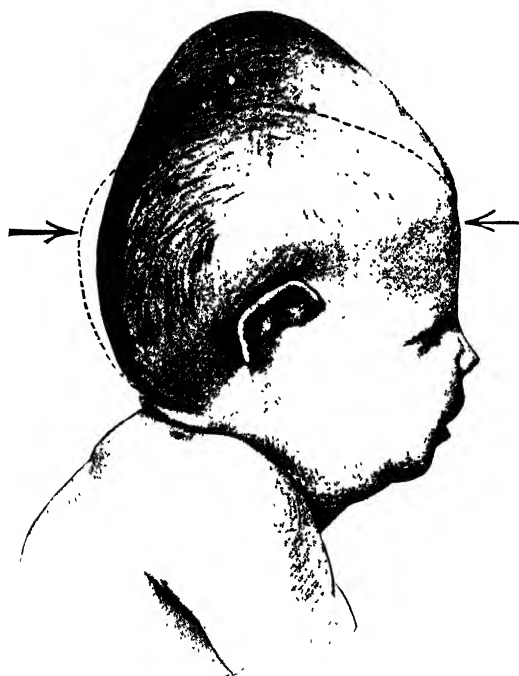
FIG. 93. Moulding of the head in persistent occipito-posterior positions.

The dotted outline shows the shape of the head before moulding. The occipito-frontal diameter has been compressed, with the result that the head has been lengthened in a vertical direction.

to the relatively sudden change in shape. Great compression along the occipito-frontal diameter usually causes tension in the posterior vertical part of the falx cerebri. This elevates the tentorium cerebelli, which may ultimately tear at its free margin. The upward dislocation of the tentorium may result in rupture of the great cerebral vein (vein of Galen) and fœtal death results from intracranial hæmorrhage. Slow moulding may allow the falx and the tentorium cerebelli to adapt themselves to the altered shape of the skull by stretching.

Management of labour

A persistent posterior position of the occiput does not always cause obstruction. Many large babies, especially in parous women, are delivered face to pubes without any difficulty. Nevertheless, owing to the increased incidence of deficient flexion of the fœtal skull in occipito-posterior position and also to the fact that this malposition may be associated with certain forms of pelvic contraction and deformity, particularly the android and anthropoid pelves, there is a greater incidence of obstructed labour compared with the occipito-anterior positions.

First stage of labour. The first stage of labour is managed exactly as described in Chapter 8. Nothing can be done to correct the malposition, or to influence the direction or amount of internal rotation of the head. The patient may walk about between the contractions if she is not tired; she is given small and frequent meals; retention of urine is not allowed to occur and, perhaps most important of all, when she is tired effective steps are taken to ensure rest and temporary relief from pain. The routine observations include an assessment of her general condition, the frequency, strength and duration of the contractions, and regular note of her temperature, pulse-rate and blood pressure. The quantity of urine secreted is measured and the urine examined for the presence of abnormal constituents, especially ketone bodies. As and when it is thought to be necessary vaginal examinations are made to estimate the progress of labour by observing the rate of dilatation of the cervix and of descent of the head. If the anterior fontanelle presents the head is poorly flexed. The finding of a large caput succedaneum or of marked overlap of the bones of the fœtal skull is most important and should be regarded as signs of probable and impending obstructed labour. As long as labour progresses, even though the progress be slow, and as long as the condition of the mother or of the fœtus gives no cause for anxiety there is no indication for any interference.

If progressive cervical dilatation does not occur Cæsarean section is now employed more frequently, and labour is seldom allowed to continue for more than 36 hours. In carefully selected cases, however, the expert may apply a vacuum extractor (Malmström cup) to the fœtal head before full dilatation. The head is pulled down onto the cervix and pelvic floor. This will encourage rotation and may effect rapid dilatation of the cervix and safe vaginal delivery. This technique should not be used until the cervix is completely effaced and is more than half dilated. Careful judgment and skill are essential and it is a method which should never be used in domiciliary practice or by the inexperienced.

Second stage of labour. When from the change in the character and strength of the contractions there is reason to believe that the patient has

entered the second stage of labour it is advisable to make a vaginal examin-
ation. This is done in order to confirm the full dilatation of the cervix and to
note the level to which the fœtal head has descended into the pelvic cavity.
Observations should also be made as to the presence and size of a caput
succedaneum, the presence of any overlap of the cranial bones indicative
of moulding of the fœtal skull, and lastly by feeling one or both fontanelles
to determine the degree of flexion of the head and its position in the pelvis.
If there are no signs of maternal or fœtal distress there is no indication for
interference at this moment. With the aid of strong uterine contractions,
helped by effective expulsive efforts of a co-operative patient who is not
tired out, an unassisted delivery, the occiput having rotated to the front,
can be expected in the majority of cases. The birth of the baby may even
take place in the face to pubes position without any serious difficulty being
experienced.

The indications for interference in the management of this malposition
of the fœtus are:

1. Failure of the presenting part to progress in spite of strong uterine
   contractions.
2. Maternal distress.
3. Fœtal distress.

(The two latter conditions are discussed fully on pp. 507 to 509.)

A thorough and careful examination must be made in order accurately
to determine the cause of the delay. In addition it is necessary to ascertain
the exact position of the fœtal head in the pelvic cavity and to note to what
level it has descended. Not before all these points have been satisfactorily
determined is it permissible, or even possible, to consider by what means
assistance can be rendered. No condemnation can be strong enough for the
haphazard application of the obstetric forceps in these cases, made in the
desperate hope that strong traction will overcome most difficulties.

The very nature of the three indications mentioned makes the necessity
for immediate interference almost certain. Therefore, the preliminary
examination should be made after the patient has been anæsthetized. This
saves the patient the discomfort of a somewhat difficult examination, and,
more important, allows this examination to be more easily and more
thoroughly performed. Arrest of the fœtal head may occur,

1. above the brim of the pelvis,
2. in the cavity of the pelvis,
3. at the outlet of the pelvis.

1. Persistent occipito-posterior position—Arrest at the brim of the pelvis

Arrest at this level is very rarely seen as non-engagement of the fœtal
head in the last weeks of pregnancy always demands a thorough investiga-
tion at that time. In most instances full dilatation of the cervix will not

have been reached. If, however, it was found in a patient who was in the second stage of labour delivery by Cæsarean section would be indicated. Under no circumstances should the application of forceps be attempted with the head above the brim.

2. *Persistent occipito-posterior position—Arrest in the cavity of the pelvis*

It is at this level that arrest usually occurs and it has already been explained that this may be due either to the malposition of the fœtal skull, or to some deformity or contraction of the pelvic cavity or bony outlet. The former results in the presentation of an unfavourable diameter, the occipito-frontal, for passage down the birth canal. Examination should, therefore, determine the level of arrest, the exact position of the fœtal head, and should decide whether the pelvic cavity is so contracted as to preclude delivery. Should gross pelvic contraction be discovered at this late hour, delivery by Cæsarean section is advised, especially if the fœtus is alive. However, it is very seldom that such is the case and delivery by the vaginal route is usual and successful. With the knowledge that the occipito-anterior position of the fœtal head presents a smaller and therefore more favourable diameter to pass through the birth canal, the first step to be taken to assist delivery is *rotation of the fœtal head*. Rotation can be performed

(a) manually,
(b) with Kielland's forceps.

The latter procedure is now frequently adopted but only by those who have been instructed in, and are familiar with, the use of the instrument.

(a) *Manual rotation.* After episiotomy the hand is passed slowly into the vagina. The head is slightly displaced upwards and firmly grasped by the fingers and thumb. Rotation is accomplished by turning the head in the appropriate direction. Thus if the position of the fœtus is right occipito-posterior the head is turned so that the occiput travels round the wall of the pelvis on the right side until the occiput is directly anterior. The opposite direction is chosen if the fœtal position is left occipito-posterior. In performing internal rotation certain points should be observed. It is a good plan to place one finger on a definite landmark of the fœtal skull, e.g. an ear, so that the exact position of the head is always known and, secondly, it is important that the shoulder girdle be rotated at the same time as the fœtal head. If this is not done the head will tend to leave the final correct occipito-anterior position after its rotation, and to slip back into an oblique or even into the transverse diameter of the pelvis. Rotation of the shoulder girdle is achieved usually by pressure on the shoulder with the outside hand through the abdominal wall. (See Fig. 94.)

Upward displacement of the fœtal head has obvious disadvantages. With elevation of the head poor flexion may be made worse and the subsequent application of the obstetric forceps much more difficult. In order to avoid

upward displacement an attempt should be made to procure the correct internal rotation of the fœtal head by pressure on the vertex in the correct direction with the tips of the fingers. In experienced and skilled hands this manœuvre is often successful. After rotation to the occipito-anterior position has been successfully completed, the obstetric forceps should be applied in the usual manner as described on page 516 and delivery of the

FIG 94.   Manual rotation of the fœtus in occipito-posterior position.

The right hand passes between the pelvic wall and the fœtal head and is about to rotate the head. The left hand placed on the abdomen will assist this rotation by pressure on the shoulder.

baby completed with the aid of this instrument. If after their application the handles of the instrument do not lock, or if satisfactory descent is not immediately apparent on moderate traction, the instrument must be removed and a careful examination must be repeated. It is quite possible that in the interval between the completion of the internal rotation and the application of the forceps the fœtal head may have rotated back to its former occipito-posterior position. The forceps, therefore, will have been applied obliquely to the fœtal head. Prolonged and forcible efforts to deliver the head in this malposition are likely to result in disaster. The instrument is

not designed to grip the fœtal head in any position other than the direct occipito-anterior position. Applied to the fœtal head in any other position traction may cause the instrument to slip off. If this happens severe lacerations will be produced to the vascular vaginal walls and underlying tissues. Great force is likely to be necessary to procure descent, because unless directly occipito-anterior, additional moulding must occur in larger diameters of the skull. Force therefore is likely to cause intracranial injury and death from intracranial hæmorrhage. Lastly it is probable that no procedure is more likely to produce a contraction ring in the uterus than the use of repeated, forcible, unskilled and unsuccessful efforts to effect delivery with the forceps.

(b) *Kielland's forceps*. This instrument is of light construction and is so designed that it can be used for the purpose of rotation of the fœtal skull, in addition to the application of traction. The pelvic curve of the shank has been greatly reduced and the lock allows one shank to slide upwards or downwards on the other while maintaining the grip of the blades on the fœtal head. In competent and experienced hands the instrument is safe and simple to use and the results consequently are most satisfactory. It is quite unsatisfactory and also dangerous in what may be termed casual use. No practitioner who has not had extensive postgraduate experience in obstetrics, or who has not been specially instructed in the application and use of the instrument must ever think of attempting rotation of the fœtal skull with this, or any other, type of obstetric forceps. The basic principles in the use of Kielland's forceps can be tabulated as follows:

1. There must exist an indication for assistance being necessary in the second stage of labour because of:
   (a) No progress in spite of good uterine contractions.
   (b) Maternal distress.
   (c) Fœtal distress.
2. Pelvic examination shows:
   (a) Arrest of the fœtal skull in the cavity of the pelvis.
   (b) That the occiput is lying in the directly posterior, obliquely posterior, or lateral position. (The last position is that in which deep transverse arrest of the head may occur. See p. 351.) The expert may also use the instrument in cases of face presentation (see p. 359).
   (c) That there is no reason to believe that vaginal delivery cannot be successfully accomplished after correction of the position of the head to the occipito-anterior position.
3. The instrument must be applied correctly and accurately to the fœtal head no matter in what position the head lies in the pelvis. An accurate application is of supreme importance. If necessary it is usually possible to apply the blades to the head even in an 'upside down' position.
4. Rotation of the fœtal head is obtained by first disimpacting the head by

slight upward pressure and then rotating the handles in the correct direction until from the position of the instrument the occiput is known to be anterior. During rotation the handles are held downwards at an angle of 45 degrees to the axis of the birth canal.

5. Traction is applied and the birth of the baby effected. .

3. *Persistent occipito-posterior position—Arrest at the pelvic outlet*

If it is found that arrest has occurred when the head is so low in the pelvic cavity that with each contraction of the uterus the fœtal scalp is easily visible, it is probable that further progress is being prevented by the muscles of the pelvic floor. To reach this level the fœtal head will already have undergone a considerable degree of moulding into the shape described for the persistent posterior position of the occiput (see p. 343). It may be found easier to perform an episiotomy and to assist the delivery of the baby with the head in the unrotated occipito-posterior position. A large diameter, albeit shortened by moulding, will have to pass through the pelvic floor and therefore the episiotomy should be adequate. Traction with the obstetric forceps must be careful and only moderate force should be used. The instrument was not designed to fit the head in this position and may slip off. Only moderate traction however is necessary to complete the delivery of a fœtal head which is arrested by the perineal muscles at this very low level.

If there is any difficulty in extraction this is due to causes other than resistance of the pelvic floor and perineum. On rare occasions severe pelvic outlet contraction with narrowing of the subpubic arch may cause arrest of the head.

This state of affairs ought to have been diagnosed at an examination of the patient in pregnancy or at least at some earlier stage in labour. If this had been done a decision might have been made as to the advisability of delivery by Cæsarean section. When arrest has occurred at this late stage steps have to be taken to complete the delivery of the baby. In such a case it is probable that the fœtal head has undergone a gross degree of moulding and that that portion of the fœtal scalp which is visible at the vaginal outlet during a contraction of the uterus covers a large and perhaps enormous caput succedaneum.

Probably the best plan, especially if the fœtus is alive, is to attempt to effect delivery by traction with the obstetric forceps. Such a 'trial of forceps delivery' should only be conducted in the operating theatre, with all preparations made for Cæsarean section. Under general anæsthesia an accurate application of the forceps is obtained. Great care and gentleness are essential. Traction must be cautious, as the grip of the instrument on the head is not likely to be secure. Failure to effect delivery from below, even following the application of forceps and even when a long period has elapsed after rupture of the membranes, would be treated by immediate

Cæsarean section. The upward displacement of the fœtal head at the time of operation is likely to be extremely difficult.

If the fœtus is dead and if infection, indicated by the presence of an offensive discharge, is present craniotomy should be performed.

Deep transverse arrest

This term denotes arrest in labour when examination shows that the fœtal head has descended to the level of the ischial spines and that the sagittal suture lies in the transverse diameter of the pelvis. The occiput is on one side of the pelvis and the sinciput on the other; flexion of the head is deficient. The condition would only be diagnosed in the second stage of labour. Unlike the persistent occipito-posterior position in which birth of the baby often occurs with face to pubes, deep transverse arrest is an invariable cause of obstructed labour.

In many cases the position of the fœtal head at the onset of labour is posterior. During labour the long anterior rotation of the occiput is arrested so that the sagittal suture remains in the transverse diameter of the pelvis. The level of arrest is at the level of the spinous processes of the ischial bones. These processes may be unduly prominent and prevent the head from descending onto the pelvic floor, where rotation of the head normally occurs. This, together with flattening of the anterior surface of the sacrum, will result in deep transverse arrest of the head. The android type of pelvis is the most likely deformity to produce deep transverse arrest.

Diagnosis. The diagnosis is made on vaginal examination during the second stage of labour. The vaginal examination is usually necessitated because the progress of labour has ceased, or because there are signs of maternal or fœtal distress. The findings on vaginal examination have already been outlined and can be listed as follows:

1. Arrest occurs at the level of the ischial spines.
2. The ischial spines may be easily felt.
3. The sagittal suture lies in the transverse axis of the pelvis.
4. Both fontanelles may be palpable indicating deficient flexion of the head.
5. Overlap of fœtal cranial bones may be felt.
6. The caput succedaneum may be pronounced.

Management. When this state of affairs is found it is necessary to take steps to assist delivery. Rotation of the fœtal head must be effected so that the occiput comes to the front and then and then only is the forceps applied. Rotation may be done manually or with the Kielland's forceps. Exactly the same procedure is followed, and exactly the same precautions are necessary as have already been described in detail when rotation of the head is necessary from the occipito-posterior position. Vaginal examination,

usually made under anæsthesia, and when necessary after an episiotomy has been performed, accurately determines the exact position of the head in the pelvis. Suture lines around the fontanelles are identified and from their position the position of the occiput determined. Confirmation of the position of the head is often obtained by the search for an ear and noting the direction in which the helix points. The right hand is passed into the vagina and the head is grasped by the thumb on the occiput and the fingers on the forehead. The fœtal head is then rotated to an occipito-anterior position. As in the case of the occipito-posterior position this rotation can often be successful with the use of the half hand only. This means the hand without the thumb; rotation is effected by tangential pressure applied to the side of the fœtal head with the fingers, without grasping the head. Following successful rotation the obstetric forceps is applied and the baby delivered.

In a neglected case the fœtal head may be found to have been driven down to a lower level and to appear almost to be wedged in the pelvic cavity. Rotation in this case will be made easier if the forehead is pushed upwards so as to disimpact and slightly flex the head. Whenever the head is being rotated the left hand should assist the concurrent rotation of the shoulders by pressure through the abdominal wall. Very rarely indeed all attempts at rotation fail. This is probably due to true impaction of the fœtal head in the pelvic cavity. If this has occurred the fœtus will certainly be dead and the safest procedure is to perform craniotomy. The slightest decrease in the size of the fœtal head usually allows its subsequent extraction with the obstetric forceps without difficulty.

Kielland's forceps are specially designed and ideally constructed to rotate the head in a case of deep transverse arrest, but the advice is repeated that their use should be limited to those who are familiar with the instrument. Note is made that in this malposition accurate application of the forceps to the fœtal head is even more difficult, and therefore in unskilled hands correspondingly more dangerous, as compared with its application to the head in the occipito-posterior position.

The ordinary obstetric forceps should never be used for rotation of the head, as severe laceration of the vagina and injury to the head will be caused.

FACE PRESENTATION

Face presentation, in which the head is fully extended, occurs about once in 300 labours, and is slightly more frequent in multiparæ than in primigravidæ. It is either primary or secondary.

Primary face presentation means that the fœtus is presenting by the face before labour begins. *Secondary* face presentation means that the head becomes fully extended during labour.

CAUSE

Fœtal deformities such as anencephaly, iniencephaly or congenita tumours of the neck will usually cause this presentation. Intra-uterine death of the fœtus by loss of muscle tone will result in a proportion of cases of face presentation.

On the other hand increased extensor tone of the fœtus may cause this malpresentation. The fœtus holds the vertebral column extended, and even
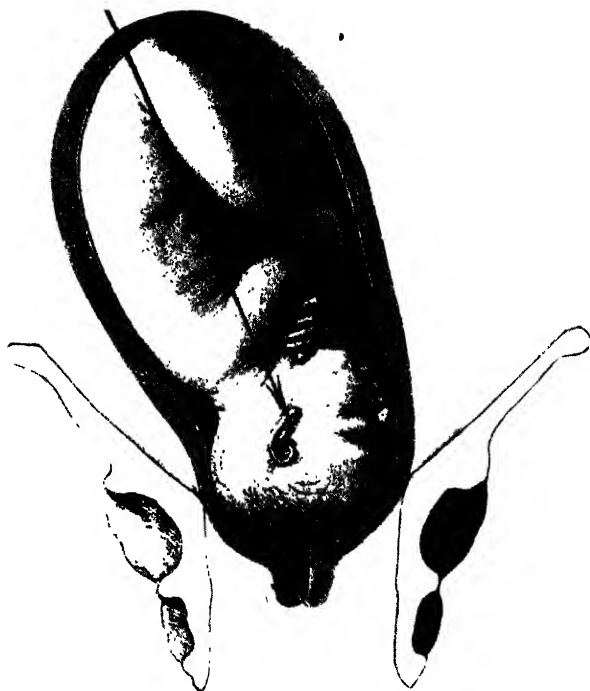
FIG. 95. Production of a face presentation by obliquity of the uterus.
The line of uterine force tends to push the occipito-spinal joint in the direction of the face and so causes extension of the head when the fœtal back is to the right.

after delivery an otherwise normal infant may keep its head in an attitude of exaggerated extension for several days. It is believed that this is sometimes the direct cause of the face presentation.

Extension of the head may occur under any of the conditions which prevent easy engagement of the fœtus, such as a flat pelvis in which the wider biparietal diameter tends to become fixed. Once the head is deflexed, as may be the case with an occipito-posterior position, uterine contractions may increase extension and thus cause a brow or face presentation.
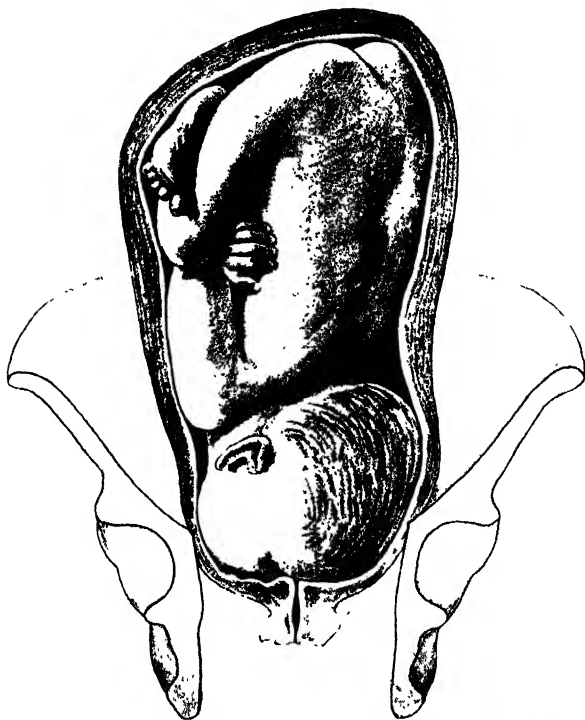
FIG. 96.   Face presentation. First (right mento-posterior) position.

The face from the chin to the bregma presents, the submento-bregmatic diameter occupying the right oblique diameter of the pelvic inlet. The back faces forward and to the left, but is extended instead of flexed as in a vertex presentation, so that the breech is more prominent and more easily palpated.

FIG. 97.   Face presentation. First (right mento-posterior) position.

Positions. The chin is the denominator and four positions are described, analogous to the corresponding positions of the vertex from which they arise.

1. Right mento-posterior (Figs 96 and 97).
2. Left mento-posterior.
3. Left mento-anterior (Fig. 98).
4. Right mento-anterior.

The mento-anterior positions are relatively more frequent because of their origin from occipito-posterior presentations, in which deflexion is more likely to occur.

MECHANISM

In a mento-anterior position the face engages and descends with increasing extension, so that the submento-bregmatic diameter (9·5 cm., $3\frac{3}{4}$ in.) comes through the cervix. When the face reaches the pelvic floor it undergoes internal rotation through one-eighth of a circle, and the submental
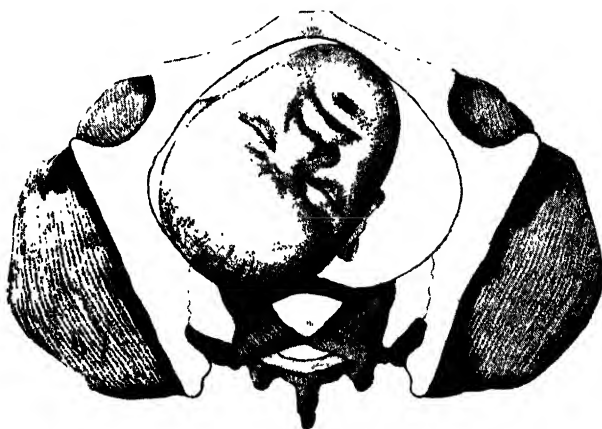
FIG. 98.   Face presentation. Left mento-anterior (third) position.

region comes to lie under the pubic arch. The head is then born by a movement of flexion, the submento-vertical diameter (11·4 cm., $4\frac{1}{2}$ in.) distending the vulva (Fig. 101). Restitution occurs and is followed by external rotation as in vertex presentations.

In a mento-posterior (first or second position), the same mechanism occurs, except that the chin has to undergo internal rotation through three-eighths of a circle (Figs. 99 and 100). Backward rotation of the chin, the persistent mento-posterior, is not common, but it cannot be delivered as such, unless the fœtus is extremely small. This is because the head is already

FIG. 99.   Face presentation. Mechanism in the right mento-posterior (first) position.

The head descends with extreme extension, so that the chin is in advance. Internal rotation of the chin forwards now occurs.

FIG. 100.   Face presentation. Mechanism in right mento-posterior (first) position.

Internal rotation of the chin almost complete. The chin has rotated from the right side of the pelvis, as indicated by the dotted lines, to lie under the pubic arch, so that the submento-bregmatic diameter is nearly in the antero-posterior diameter at the pelvic outlet.

fully extended, and further extension to deliver the head through the out-let is quite impossible. The head and shoulders become impacted in the pelvis, and obstructed labour will occur unless assistance is given. •

Moulding. In a face presentation the submento-vertical diameter of the head is compressed, causing elongation of the occipito-frontal diameter (Fig. 102). This shape of head is called dolichocephaly. The cartilaginous fusion of the facial bones makes the face a relatively rigid structure, so that moulding of the head in face presentations is slight.

DIAGNOSIS

Abdominal examination. In a mento-posterior position, the cephalic prominence is very readily felt and appears to overlap the symphysis pubis; it is felt on the same side as the back, from which it is separated by a deep

FIG. 101. Face presentation. Birth of the face.

Internal rotation has occurred, bringing the chin under the pubic arch. The head now escapes by a movement of flexion, its submento-bregmatic and then submento-vertical diameters in turn distending the vulva.

sulcus. It is difficult to feel the upper part of the back, while the podalic pole is unduly prominent. The fœtal heart may be indistinct and difficult to locate.

In a mento-anterior position, the cephalic prominence is again felt on the same side as the back, but the latter, being posterior, is difficult to feel, and the very prominent chest may be mistaken for it, thus leading to a mistaken diagnosis of a flexed vertex. The fœtal heart is easily heard over

the chest, and an important diagnostic point is the finding of small parts on this same side (Fig. 103). X-rays will settle the diagnosis in a doubtful case.

Vaginal examination. Early in labour it may be difficult to reach the presenting part. As the face is more irregular than the vertex, the bag of membranes tends to elongate and rupture early. When the presenting part
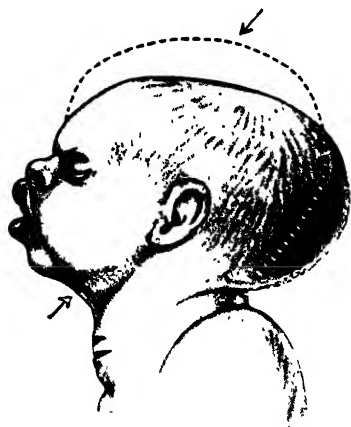
FIG. 102. Moulding in face presentation.

The arrows indicate the direction of the pressure which shortens the diameter between the submento-vertical and submento-bregmatic diameters. The splitting of the skin in the front of the neck and the swelling of the face are also shown.
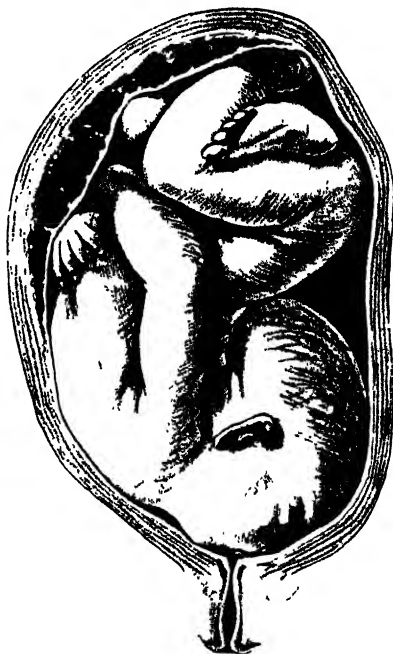
FIG. 103. Face presentation. To show findings on abdominal examination.

In mento-posterior positions, the marked prominence of the occiput will be found on the same side as the back. Above this an interval may be detected before the back is felt running up into the unduly prominent breech.

In mento-anterior positions the small parts are very distinctly felt owing to the way they are thrust forward towards the abdominal wall. On auscultation the heart-sounds may be heard most plainly on the same side as the small parts are felt.

has engaged in the brim and can be explored by the finger, the hard alveolar margin of the mouth, the bridge of the nose and the supraorbital ridges will be recognizable. Care should be taken not to injure the eyes

and mouth when palpating the face. When a caput succedaneum has formed the face may be confused with a breech. This mistake should not be made if the abdomen has been examined, and furthermore the mouth can be identified by the presence of alveolar ridges. If in doubt, a finger should be passed round the side of the presenting part to feel for an ear. The diagnosis of position is made by noting the direction of the chin.

PROGNOSIS

Many face presentations are delivered naturally and without the slightest difficulty. On the other hand, the causes determining the face presentation sometimes affect the outlook for both mother and child, especially in cases of disproportion at the pelvic brim. Apart from this, face presentations are somewhat less favourable than vertex presentations, because the face is a less efficient dilator of the cervix than the vertex, because moulding is less pronounced, and because spontaneous rotation of the posterior positions is more difficult and occurs late in the second stage of labour.

The emerging diameter, submento-vertical ($11 \cdot 2$ cm., $4\frac{1}{2}$ in.), is larger than in the normal vertex. With the mento-posterior positions the prognosis for both mother and child is less favourable than when the chin is in front, because of the delay and resulting obstruction necessitating intervention if forward rotation does not occur.

MANAGEMENT OF LABOUR

In the majority of cases, especially in multiparæ, spontaneous delivery can be expected.

The patient must be kept in bed during the first stage, and a vaginal examination made as soon as the membranes rupture, to exclude prolapse of the cord. Attempts to convert the face into a vertex are unwise, as a brow presentation may result. Infiltration of the perineum with $\frac{1}{2}$ per cent lignocaine hydrochloride and episiotomy are advisable in primiparæ if there is any undue delay when the presenting part has reached the pelvic floor.

With a mento-anterior position spontaneous delivery is to be expected. If there is delay in the second stage due to inadequate expulsive forces there is no difficulty in applying the forceps.

With a mento-posterior position time should be allowed for spontaneous rotation, which will only occur late in the second stage. If spontaneous rotation does not occur manual rotation of the head to the mento-anterior position may be attempted (Fig. 104), but the expert may prefer rotation with Kielland's forceps. General anæsthesia is required, and after the rotation delivery is completed with forceps.

FIG. 104.   Persistent mento-posterior position.

Manual rotation of the face to bring the chin forwards with rotation of the body by pushing over the anterior shoulder. Before attempting this the head is pushed up to overcome impaction.

FIG. 105.   Appearance of the face after delivery in a face presentation.

Cæsarean section is only necessary when there is some complication, such as contracted pelvis or prolapse of the cord, or when the presenting part fails to descend. In a neglected case in which impaction has occurred with obstructed labour and fœtal death the head can be perforated through the orbit to facilitate delivery.

The face is always somewhat swollen and discoloured after a face delivery and the parents should be warned that it may be temporarily unsightly (Fig. 105).

BROW PRESENTATION

The causes of a brow presentation are almost the same as those of a face presentation. Primary extension of the head may be due to increased fœtal extensor tone. Secondary extension may occur in a case in which the descent of the biparietal diameter is prevented by pelvic contraction, but a more
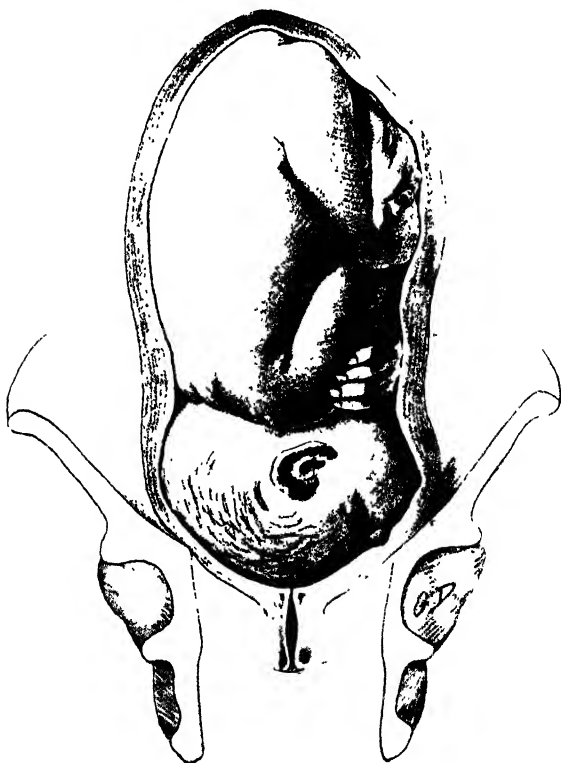
FIG. 106.   Brow presentation.

The above head is above the brim and not engaged. The mento-vertical diameter of the head is trying to engage in the transverse diameter at the brim.

common type of secondary extension occurs in cases of occipito-posterior position without disproportion. In these the wide occipital end of the head lies in ·the sacro-cotyloid bay of the pelvis, where it may be arrested, so that the sinciput descends and extension of the head occurs in the cavity of the pelvis.

All face presentations must pass through the stage of partial extension, but a persistent brow is fortunately rare. If the head lies with its longest diameter, the mento-vertical (13·3 cm., 5¼ in.) across the pelvic brim, only an
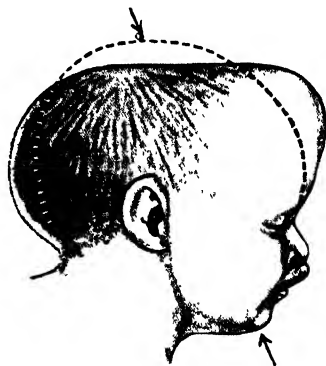
FIG. 107.   Moulding in brow presentation.

The arrows indicate the direction of the pressure which shortens the vertico-mental and lengthens the occipito-frontal diameters.

exceptionally small fœtal head will engage in an average pelvis. With a fœtus of average size obstructed labour will therefore result and there would be no mechanism to describe (Fig. 106).

Strong uterine action will cause marked moulding of the head, compressing the mento-vertical diameter and lengthening the occipito-frontal (Fig. 107). When the fœtal head is very small in proportion to the pelvis and is partly extended, it may be driven down into the pelvic cavity and may actually be born as a brow presentation.

DIAGNOSIS

In cases in which extension of the head occurs early in labour the diagnosis is usually difficult. On abdominal examination the head is above the brim, with definite overlap, and the cephalic prominence is on the same side as the back. This malpresentation should always be suspected when non-engagement of the head is noted early in labour particularly in the case of the patient who has had previous easy deliveries. As a rule the membranes rupture early in labour.

On vaginal examination, except in cases in which the malpresentation is

the result of extension of a head lying in the occipito-posterior position in the pelvic cavity, the presenting part will be high. The examining finger generally touches the middle of the frontal suture; if this is followed in one direction the anterior fontanelle will be identified, and in the other direction the root of the nose and orbital ridges will be found (Fig. 108).

MANAGEMENT

A careful investigation should be made to determine the cause leading to extension of the head, and especially to decide whether there is any pelvic contraction. A short trial of labour should be permitted, and this may result in further extension of the head to a face presentation and engagement in the pelvic brim. If the head fails to engage delivery by Cæsarean section is indicated. In no circumstances should vaginal manipulations be attempted with the head above the pelvic brim.
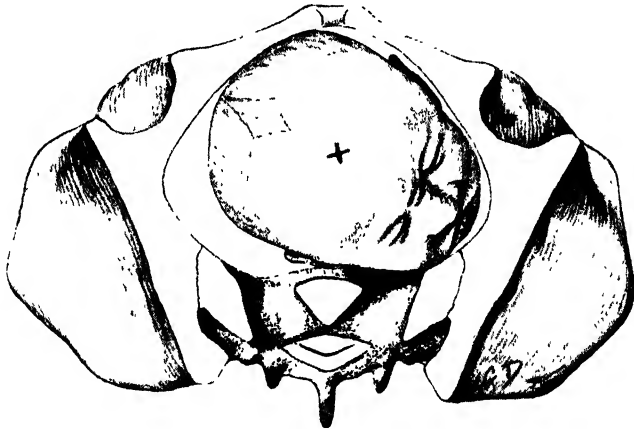
FIG. 108. Brow presentation.
On vaginal examination the finger usually touches the middle of the frontal suture marked ×.

If the head has entered the pelvic cavity and the brow presentation is discovered when the cervix is fully dilated manipulation is justified. Under general anæsthesia a hand is inserted behind the occiput in the hollow of the sacrum. The head is flexed to a vertex occipito-posterior position and then without withdrawing the hand immediately rotated to the occipito-anterior position. Delivery is then completed with the forceps. Alternatively, Kielland forceps may be used to effect flexion and rotation.

Some obstetricians have recommended that the brow presentation should be extended to a face presentation, but there is less room for manipulation behind the symphysis pubis, and conversion to a vertex presentation is preferable.

BREECH AND SHOULDER PRESENTATIONS

BREECH PRESENTATION

BREECH presentation occurs in about 3 per cent of labours, but breech presentation is found more commonly than this before term, in about 25 per cent of pregnancies at the 30th week, and the incidence is therefore higher in premature births. Spontaneous version occurs in a large number of breech presentations by the 34th week.
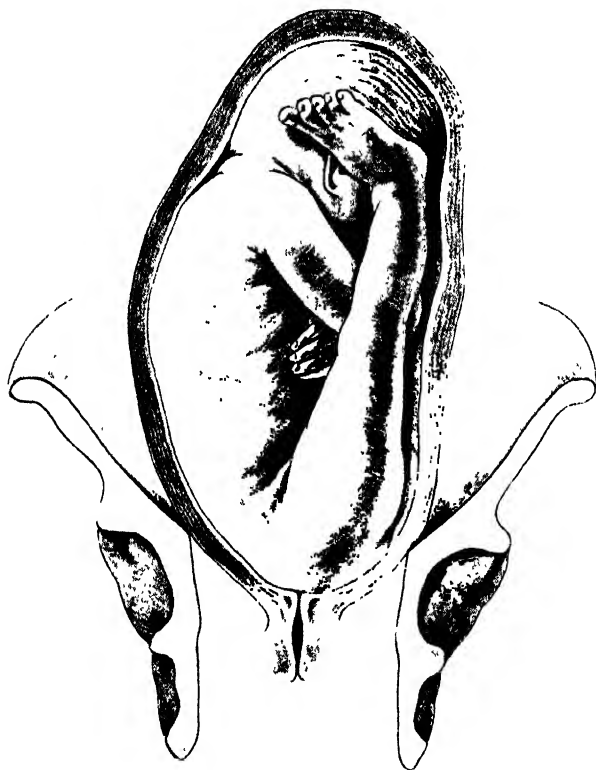
FIG. 109.   Frank breech presentation with extension of the legs.

There are four kinds of breech presentation:
1. Frank breech (Fig. 109). The legs are fully flexed at the hip and fully extended at the knee. This is the commonest type of case, especially in primigravidæ.

2. Complete breech (Fig. 110). The legs are fully flexed at both hip and knee.

3. Footling breech. The legs are fully flexed at the knee but partially extended at the hip.

4. Half breech. Both legs are extended at the knee, but one leg is fully flexed at the hip so that the foot is in the uterus and the other hip is fully extended with the foot in the vagina. This does not occur spontaneously but is the result of internal podalic version.
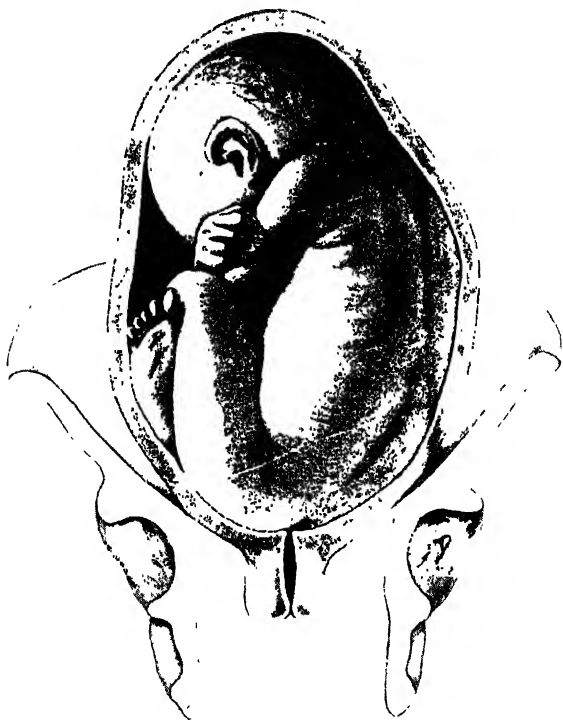
FIG. 110. Complete breech presentation with flexion of the legs.

In the frank breech the buttocks accurately fit the lower uterine segment and cervix, and cord prolapse is an uncommon complication, whereas it may sometimes occur with the other types.

Extension of the arms above the head may occur during labour whether the legs are flexed or extended.

CAUSATION

In mòst instances breech presentation occurs by chance and there is no other underlying abnormality. Before the 30th week of pregnancy the uterine cavity is more or less spherical and the long axis of the fœtus may lie in any direction. In late pregnancy the cavity is ovoid, with the fundus wider than the lower pole. Fœtal limb movements normally turn the fœtus until the flexed legs occupy the more spacious upper part of the cavity and the head fits into the narrower lower part. If fœtal kicking movements are ineffective because the legs are extended, or if the frank breech becomes engaged in the brim, then a breech presentation will persist. Further fœtal growth makes the free space in the uterus relatively less, and spontaneous version becomes less possible as term is approached.

If there is an excess of liquor free fœtal movement may continue, and a breech presentation may occur by chance. For the same reason malpresentations may occur in the case of a multipara with lax uterine and abdominal musculature.

Contrariwise, if pregnancy occurs in one horn of a double uterus breech presentation is common, as such a horn tends to be narrow with the widest pole below.

With twin pregnancy either fœtus may prevent the head of the other from engaging, and will also prevent free movement in the uterus, so that malpresentations are common.

In a small proportion of the cases some underlying pelvic abnormality will be discovered which prevents the head from entering the pelvis, and in some of these cases a breech presentation may occur. Such abnormalities include placenta prævia, contraction of the pelvic brim, and pelvic tumours. In the same way breech presentation may occur in cases of congenital malformation such as hydrocephalus.

The following list of the causes of breech presentation may be abstracted from the account just given:

1. No evident abnormality.
2. Prematurity.
3. Hydramnios.
4. Multiparity.
5. Uterine malformation.
6. Multiple pregnancy.
7. Placenta prævia.
8. Contracted pelvis.
9. Pelvic tumour.
10. Fœtal abnormality.

Positions of the breech. The four positions of the breech are:

1. Left sacro-anterior (L.S.A.) (Fig. 111).
2. Right sacro-anterior (R.S.A.).
3. Right sacro-posterior (R.S.P.) (Fig. 112).
4. Left sacro-posterior (L.S.P.).
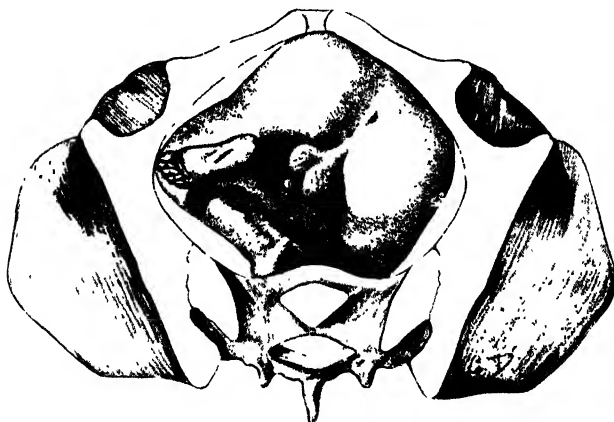
FIG. 111.   Breech presentation. First position (L.S.A.).
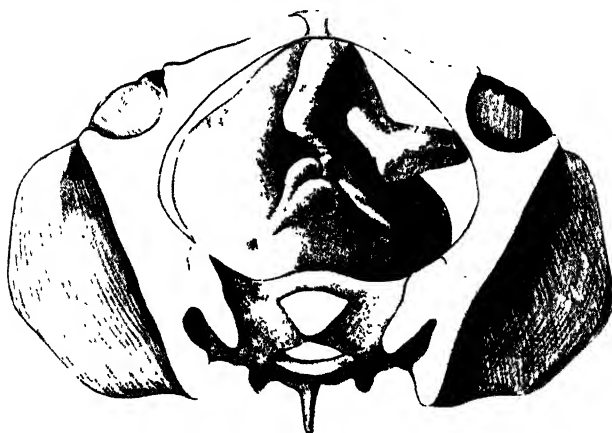
FIG. 112.   Breech presentation. Third position (R.S.P.).

THE DIAGNOSIS OF BREECH PRESENTATION

(a) *During pregnancy.* The diagnosis is made during pregnancy, and in labour before the rupture of the membranes, by abdominal examination. When the breech presents examination of the lower pole of the uterus fails to demonstrate the presence of the hard fœtal skull. Mid-abdominal

examination shows the position of the fœtal back. The fœtal head is felt as a hard, spherical and easily movable object in the fundus uteri and frequently the patient herself may state that she has noticed considerable discomfort in this region. Admittedly the breech of a mature fœtus may feel hard or firm, but is it never so movable as is the head. When the uterus contains a considerable amount of liquor amnii the fœtal head can be ballotted from side to side. The fœtal heart is usually best heard at a higher level than is the case in a cephalic presentation. The point of maximal intensity is at the level of or slightly above the umbilicus, but this sign is not absolutely reliable.

Occasionally, perhaps owing to the thickness of the abdominal wall, the diagnosis is extremely difficult but vaginal examination will often resolve the difficulty. If doubt still remains, X-ray examination should be considered.

(b) *In labour*. After rupture of the membranes additional information can be obtained from the findings obtained by vaginal examination. In the breech with flexion of the legs a foot may present and easily be felt. This must be diagnosed from a hand. In the frank breech superficial examination may mistake the buttock for the fœtal skull but the hardness of bone is absent. The anterior buttock is felt first and is separated from the posterior buttocks by the anal cleft and genital organs. Three bony landmarks should be identified to determine the position; the ischial tuberosities on either side of the anus and the sacrum behind. The absence of the feet and legs will confirm the diagnosis of extension of the legs. The breech is sometimes confused with a face or shoulder presentation on vaginal examination, particularly if the parts are œdematous. The presence of the alveolar ridges in the mouth distinguish it from the anus. If the examining finger is passed into the anus it will be gripped by the anal sphincter, but this may cause soft tissue damage and palpation of bony landmarks is preferable. Ribs can be felt in a shoulder presentation. In a footling presentation the foot is identified by the heel and by the fact that the great toe cannot be abducted to the same extent as the thumb.

Flexion or extension of the legs

In both primigravidæ and multigravidæ the legs are usually found to be extended at the knees and fully flexed at the hips. This permits the narrow cone of the buttocks to pass into the pelvic cavity. This fixation of the buttocks in the pelvic brim and the splinting of the trunk by the legs will make external cephalic version more difficult.

At one time it was also believed that extension of the legs provided a complicating factor to the descent of the fœtus down the birth-canal. During descent lateral flexion of the fœtus must occur and it was thought that the presence of the extended legs acted as a splint which prevented

such lateral flexion. In practice this is not the case, and the frank breech usually descends easily and is as efficient as, if not more efficient than, the vertex, in the manner in which it assists in the dilatation of the cĕrvix.

PROGNOSIS

The fœtal mortality is higher in breech than in vertex presentation even if complications such as pelvic contraction, placenta prævia and fœtal abnormalities or prematurity are excluded. In cases of complicated breech presentation, particularly those iŋ which the fœtus is premature, the fœtal mortality may be as high as 20 per cent; but in mature uncomplicated cases the fœtal mortality is between 2 and 5 per cent.

The increased mortality in mature uncomplicated cases is due to:

      1. Intracranial injury
      2. Death of the fœtus from anoxia.

1. *Intracranial injury.* The risk of tentorial tear and cerebral hæmorrhage is greater with an aftercoming head. Less time is available for moulding to occur, and rapid compression of a badly flexed head is particularly likely to produce this injury. This cause of death accounts for almost half the perinatal mortality in breech delivery.

Breech birth is particularly dangerous in the presence of even slight disproportion between the bony pelvis and the fœtal head. Pelvic contraction should have been suspected, and diagnosed, at prenatal examinations. If in a primigravida a breech presentation persists every effort should be made, including X-ray pelvimetry, to prove the normal size and structure of the pelvis, before the onset of labour. Multiparity, the previous confinements having been normal and easy, should certainly not indicate complete freedom from anxiety in the birth of a subsequent baby presenting as a breech. A large fœtus can cause disproportion just as readily as can a slightly contracted pelvis and often the fœtus increases in size with increasing parity.

2. *Interference with the placental circulation* is more liable to occur. It results from compression of the umbilical cord by the aftercoming head, and also from uterine retraction which may cause separation of the placenta before the birth of the head. Delay in the delivery of the head for more than 10 minutes after the body has been born is very likely to endanger the baby's life by asphyxia. Even if the delay is not as long as this there is some risk to the fœtus from premature inspiration with the aftercoming head undelivered, when mucus may be inhaled into the air passages and obstruct them after delivery.

Fœtal asphyxia may also be due to prolapse of the umbilical cord. This is rare with a frank breech, but more likely to occur with a flexed breech.

Taking into account the three causes of perinatal mortality mentioned

above, together with the association of breech presentation with other complicating factors the following conclusions have proved to be fully justified.

(a) A woman with a breech presentation should be delivered in hospital.

(b) The delivery of the baby must be in the hands of someone who is thoroughly experienced in the care and management of this abnormal presentation.

The considerable improvement in the perinatal mortality which has taken place is undoubtedly due to a gradual acceptance of these two recommendations.

External cephalic version. Because of the high fœtal mortality in breech delivery if the fœtus presents in this way it should be turned by external cephalic version into a cephalic presentation during the antenatal period whenever possible. In primigravidæ version is particularly desirable. It is usually possible to determine those cases in which it is likely to succeed. It is useless to attempt it if the amount of liquor amnii appears to be small and if the fœtus seems to fill a uterus the muscular wall of which is tense.

Other contra-indications to version are:

1. Gross pelvic contraction, when Cæsarean section is necessary. There is no purpose in attempting version is such a case, but in a case of doubtful disproportion version may be useful so that a trial labour can subsequently be conducted.

2. Placenta prævia or other cause of antepartum hæmorrhage, because of the risk of causing hæmorrhage by further placental separation.

3. Pre-eclampsia or essential hypertension, because of the risk of causing antepartum hæmorrhage.

4. Twins, when version is not possible because the second fœtus prevents it.

External cephalic version can be attempted at any time in pregnancy at which the diagnosis of breech presentation has been made, but before the 34th week it is doubtful whether the attempt is advisable, or even necessary, because in so large a proportion of cases spontaneous cephalic version is likely to occur. In most women after the 38th week of pregnancy version, owing to the size of the fœtus and the relative decrease in the amount of liquor amnii, is unlikely to be successful.

Before version is attempted the exact position of the fœtus must be determined and the fœtal heart must be heard. Better relaxation of the muscles of the abdominal wall will be obtained if the knees are slightly flexed. The first step in external cephalic version is to disengage the breech from the pelvic brim. This is done by lifting it upward by pressure with the fingers of both hands through the abdominal and uterine walls. The lower part of the uterus is always slightly tender and the patient will resist

the use of any undue force. Occasionally the breech cannot be disengaged, in which case no further attempt at external version should be made. When

FIG. 113. External cephalic version.
The breech has been disengaged from the pelvic inlet. Version is first attempted as shown above.

FIG. 114. External cephalic version.

the breech has been lifted out of the pelvis it is held in this position by one hand while the other hand presses on the fœtal head in such a direction as

to increase the attitude of flexion. Version is usually successful as the result of steady prolonged pressure. Jerky movements should not be made. They will cause pain and the patient will be likely to resist all further efforts.

FIG. 115. External cephalic version completed.

FIG. 116. The fœtal heart having been heard attempts are made to ensure the satisfactory engagement of the fœtal head into the brim of the pelvis.

After successful version the fœtal heart must be auscultated once more and an attempt should be made to make the fœtal head engage in the pelvic brim. Vaginal bleeding indicates placental detachment.   •

Anæsthesia should only be considered after attempts at cephalic version have failed in the conscious patient. There are certain objections to the use of anæsthesia, and indeed there are some who doubt whether an anæsthetic should ever be used for external cephalic version. Deep anæsthesia is essential. Version under light anæsthesia can be more difficult than in the conscious patient; the latter can at least try to relax her muscles. The fact that an anæsthetic is necessary worries the woman far more than most practitioners realize. Increased force is very liable to be used when the patient is anæsthetized leading to such untoward events as the onset of labour, detachment of the placenta and intra-uterine death of the fœtus probably due to obliteration of the circulation of the umbilical cord which has become twisted round a limb in the process of version. Moreover, the dangers of breech delivery seem to be decreasing steadily and the time has come when each individual practitioner must assess his skill at external cephalic version against his ability safely to conduct the delivery of a fœtus presenting by the breech.

It is not possible, therefore, to be dogmatic regarding anæsthesia. If, however, the decision is made to attempt external cephalic version under anæsthesia the only anæsthetic agents that will give the necessary relaxation are ether and fluothane (halothane). The former is safe but unpleasant; the latter is preferable in skilled hands. Relaxants do not diminish the tone of the uterine muscle, nor do they abolish uterine contractions. The procedure in version under anæsthesia is identical with that in the conscious patient, but the operator must always refrain from the use of undue force. Perhaps the greatest advantages of the anæsthetic are that it allows the breech to be disengaged by upward pressure from below and that it allows of a very much more thorough pelvic examination to determine the absence of disproportion. If version is unsuccessful and there is any doubt about the pelvic capacity Cæsarean section will be seriously considered for the delivery.

Mechanism of labour

The bi-trochanteric diameter (10·2 cm., 4 in.) engages in an oblique diameter of the pelvic brim, usually with the back in front. The breech descends into the pelvic cavity and internal rotation then brings the bi-trochanteric diameter into the sagittal plane of the outlet. The breech is born by lateral flexion of the trunk, the anterior buttock appearing first (Fig. 117). This movement of lateral flexion is produced by the curve in the birth-canal, and less flexion is necessary with a relaxed or deficient perineum. The delivery may be delayed by a rigid perineum.

The baby's abdomen is born by further descent, and some external rotation may be observed as the bisacromial diameter engages in the oblique diameter of the brim. The anterior shoulder normally emerges first from under the pubic arch, and is quickly followed by the posterior shoulder (Fig. 117). The flexed head engages more or less in the transverse diameter of the brim, and forward rotation of the back will be observed as the head
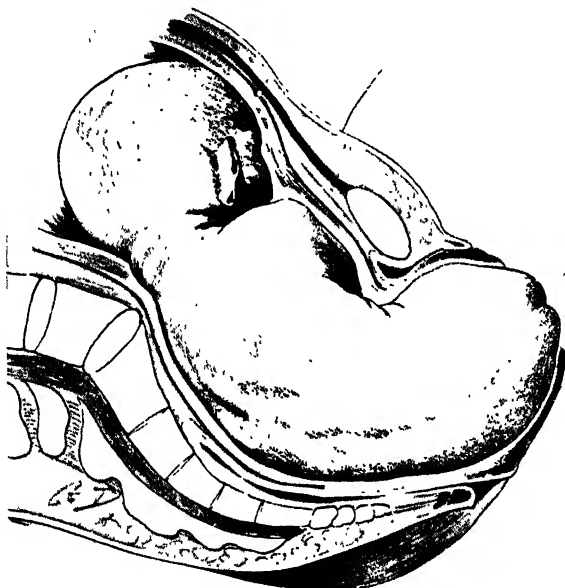
FIG. 117.   Lateral flexion of the body during delivery of the breech.

The anterior (right) buttock is under the pubic arch, and the posterior (left) is escaping over the perineum. The child's sacrum looks directly to the mother's right side, and the body is flexed round the symphysis. The shoulders are entering the pelvis in the same oblique diameter as that previously occupied by the buttocks, so that there is also a slight twist on the body.

descends into the pelvic cavity and undergoes internal rotation, the occiput coming to lie behind the symphysis pubis. The neck rests under the pubic arch, and the head is born by a movement of flexion (Fig. 119). Very occasionally posterior rotation of the occiput occurs and the head is born face to pubes. This mechanism is less favourable as the occipito-frontal diameter distends the vulva.

Management of labour

First stage. It is assumed that before labour starts the diagnosis of a breech presentation has been correctly made and that a thorough examination has failed to demonstrate any abnormality in the pelvic size or shape, or

in the fœtus. In these circumstances the conduct of labour is exactly as described in the management of this stage in the case of a vertex presentation. Early rupture of the membranes may occur, as the fit of presenting part is not such as to prevent the membranes being subjected to the full force of each contraction.
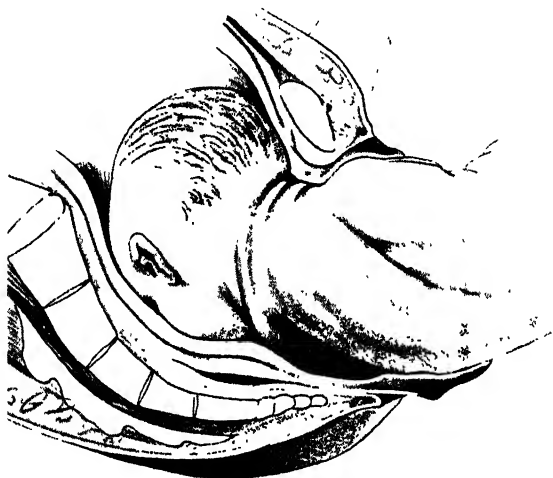
FIG. 118. Rotation forwards of the occiput in the third position of the breech. The anterior shoulder is born, the posterior is on the perineum. Lateral flexion of the body is still present. Rotation of the after-coming head so as to bring the nape of the neck under the pubic arch and the occiput behind the symphysis is occurring.

As soon as the membranes rupture a vaginal examination should be made to exclude prolapse of the umbilical cord. Prolapse of the cord is more likely to occur in cases with the legs flexed (complete or footling breech). It is doubtful if rupture of the membranes is delayed by keeping the patient lying down. Regular and effective contractions are more likely to occur if the patient is up during the earlier part of labour. If good progress has been made after twelve hours in a first labour it is unlikely that there will be any difficulty in the subsequent delivery. Throughout this stage of labour a watch is kept, as always, for failure of progress, and for evidence of maternal or fœtal distress.

Second stage of labour. Spontaneous delivery of the breech may occur in a large proportion of cases whether the legs be extended or not, especially in parous women. In both primigravidæ and multiparæ the second stage is allowed to continue so long as descent of the presenting part is uninterrupted and in the absence of signs of maternal or fœtal distress. When the breech reaches the pelvic floor, or if at any time it is necessary to make a

pelvic examination to discover the cause of delay, the patient should be placed in the lithotomy position.

In the case of a primigravida nitrous oxide and oxygen or trilene analgesia should be given with each contraction to relieve the pain; episiotomy should be performed as a routine under local anæsthesia. This is done in order that the intact pelvic floor shall not provide any obstacle to the delivery of the breech and to facilitate the ultimate delivery of the fœtal head. Routine episiotomy is not necessary in a parous woman.

FIG. 119.   Birth of the after-coming head.

The nape of the neck is under the symphysis, the chin is escaping over the perineum. In delivery the child's body is supported by holding the ankles. The arrow indicates the direction of maternal expulsive efforts. Sudden expulsion of the head may be prevented by gentle pressure on the brow.

In the case of the complete breech the feet and legs present and as they appear they are eased out with appropriate digital pressure. If the legs are extended the anterior buttock first becomes visible and is allowed to descend with each contraction (Fig. 120). The minimum of assistance is given by digital traction in the groin (Fig. 121). As the breech is born further assistance may be given by traction in the posterior groin. Traction should only be exerted when the uterus is contracting. Nearly all cases can be delivered by this method for which a general anæsthetic is not necessary.

As has already been stated progress in labour may be arrested, but very rarely, before the presenting breech has reached the level of the pelvic

floor, or in other words, in the cavity of the pelvis. This situation demands an immediate and thorough examination to determine the cause, because it is usually due to contraction of the bony pelvis or the presence' of an unduly large fœtus. A more satisfactory examination can only be made if the patient is anæsthetized.

If it is considered that the degree of pelvic contraction is such as to provide inevitable and great difficulty in the subsequent extraction of the child, delivery by Cæsarean section should be performed.
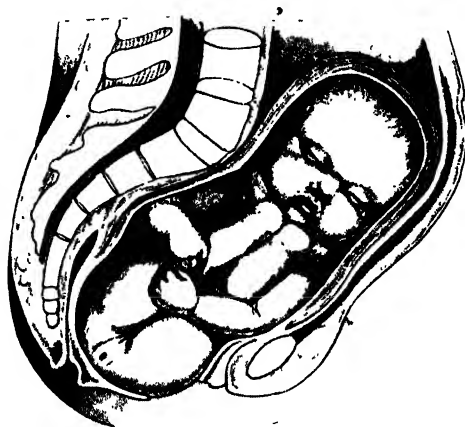
FIG. 120. Breech with extended legs.

The breech is smaller than the flexed breech and than the head. It has entered the brim easily, but having descended deeply into the cavity of the pelvis is arrested by the perineum.

Breech extraction under general anæsthesia is only indicated if immediate delivery is essential because of maternal or fœtal distress. It should never be employed to overcome disproportion or a rigid pelvic floor. In the presence of pelvic contraction or a large fœtus attempts at extraction will often end in disaster and Cæsarean section is preferable.

If there is a valid indication for breech extraction the patient is anæsthetized and her bladder is emptied. The whole hand is inserted into the vagina and the breech is pushed upwards to the level of the pelvic brim. The anterior leg is brought down first, by pressing into the bend of the knee and abducting the thigh. Aided by abdominal manipulations with the other hand, the knee will flex and the foot can be grasped and brought down. The posterior leg can now be brought down in a similar manner, and delivery proceeded with. Unless each leg is first flexed, pulling on the knee may fracture the baby's femur.

Breech extraction at an earlier stage of labour, before the cervix is fully dilated, is attended by a higher fœtal mortality. The undilated cervix tightly grips the body of the child. As the baby is extracted the cervix prevents descent of the arms which inevitably become extended. The difficulties of extraction of the fœtal head through an undilated cervix are obvious and efforts made to provide assistance are most likely to produce severe cervical lacerations. It may very occasionally be necessary to assist

FIG. 121.   Traction of the anterior groin in a sacro-posterior position of the breech with extended legs.

The breech has descended deeply into the pelvis so traction with a finger in the groin completes the delivery usually after an episiotomy has been performed.

delivery before complete dilatation of the cervix on account of fœtal distress, if, for example, the cord has prolapsed and become compressed but this should only be attempted in the case of a multigravida. In a primigravida Cæsarean section is safer for the fœtus.

Whether the breech has been delivered spontaneously or with assistance, the pulsation of the cord may be observed and this will show that the fœtus is alive. Compression of the cord by the side walls of the birth canal may sometimes cause spasm of the umbilical vessels and obliterate the fœtal pulse. An absence of pulsations during delivery is not an indication for haste. Rapid extraction of the fœtus may cause death from intracranial hæmorrhage.

A finger should now be inserted into the vagina to make certain that the arms are lying folded on the chest. As delivery of the shoulders proceeds

FIG. 122. Lövset's manœuvre.

the baby's body should be allowed to hang downwards to exert slight traction in the direction of the pelvic axis. As soon as the head has descended on to the pelvic floor and the nape of the neck can be seen below the pubic arch, the baby's legs should be firmly grasped just above the ankles and by exerting slight traction, the baby's body is lifted upwards to the horizontal position. The face will then appear at the vulva and, as the baby can now breathe, the head can be delivered slowly and carefully. It is most important to realize that lifting the baby's body upwards before the head has passed completely through the brim, will not assist delivery, and may injure the cervical spine.   •

Extension of the arms. Spontaneous delivery may be delayed in cases of extension of the arms unless the fœtus is extremely small, and assistance must be given as soon as the diagnosis has been made. Extension of the arms should be suspected if descent of the fœtus is not continuous after the delivery of the thorax and if examination shows the absence of the arms from the pelvic cavity. This complication must be dealt with at once as extension of the arms will prevent the completion of delivery at a most critical moment. There are two methods that can be employed to deliver extended arms, that described by Lövset and the so-called classical method. The former is the method of choice as it is most effective and involves no intrapelvic manipulations which will lessen the risk of injury to the mother or fœtus. The principle of Lövset's manœuvre is based on the knowledge that as the result of the curvature of the birth-canal the posterior shoulder must be at a lower level than the anterior shoulder. Therefore by downward traction, the anterior shoulder is brought to lie behind the symphysis pubis so that the inferior angle of the anterior scapula can be felt. When this is done the posterior shoulder must lie below the promontory of the sacrum and therefore below the pelvic brim. The pelvic girdle and thighs are then firmly gripped by both hands and the fœtus turned through 180° so that the fœtal back always remains upwards. Moderate traction is used during the process of rotation. By this means the posterior shoulder is brought to the front and inevitably appears beneath the symphysis pubis. The arm may be delivered spontaneously; if not, it can easily be hooked out by digital pressure. The other shoulder which previously lay anteriorly and above the brim of the pelvis now lies in the hollow of the sacrum. The fœtus, therefore, is rotated through 180° in the opposite direction, the fœtal back again being kept upwards. The remaining arm is thereby easily delivered.

The classical method necessitates a general anæsthetic. A firm grasp is taken of the legs, and fairly strong traction exerted in the axis of the pelvis. The trunk is then lifted upwards to swing the posterior shoulder into the hollow of the sacrum, and a hand is inserted into the vagina, along the

FIG. 123. Extended arms: bringing down the posterior arm (classical method). The child's body is swung up towards the mother's abdomen. Two fingers of the left hand are being passed up to the bend of the elbow to flex the arm and bring it down with a wide sweep across the child's face.
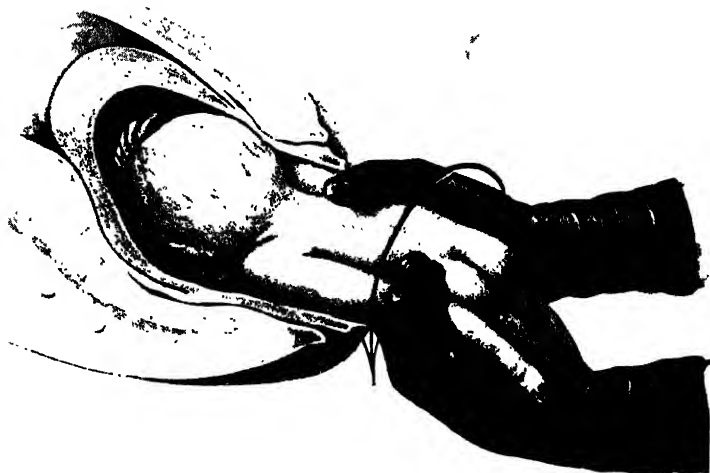
FIG. 124. Extended arms: rotation of the body to disengage the anterior arm (classical method).
The anterior arm is tightly wedged behind the symphysis. The child's body is rotated in the direction which will bring the arm across the face.

lateral and posterior wall of the chest until the elbow is reached (Fig. 123). Two fingers are placed along the humerus and pressure made on the ante-cubital fossa to flex the forearm, which can then be swept down in front of the face. Once the posterior arm is delivered, the trunk will have to be rotated so that the anterior shoulder comes to lie in the hollow of the sacrum, and it should be rotated in the direction which will bring the arm across the face (Fig. 124). If dorsal displacement of the arm behind the

FIG. 125. Dorsal displacement of the arm.

To undo this displacement the body is rotated so as to make the face look towards the displaced arm. The fingers grasp the child by the thorax, not the abdomen.

neck should occur, the trunk should again be rotated in such a manner that the face moves towards the extended arm (Fig. 125). For such rotation the baby's thorax must be firmly grasped by both hands, and care taken not to injure the liver or other viscera. Manipulations of the arms must be gentle to avoid fracture or nerve injury.

The classical method demands the insertion of the hand into the vagina alongside the fœtal trunk. This is attended by a high risk of severe maternal lacerations. Lövset's manœuvre is now preferred, and it is more effective when the arms are extended.

Difficulty with the aftercoming head

Following the birth of the shoulders the flexed head enters the pelvis in the transverse diameter of the brim. As descent occurs forward rotation of the back will be noticed and this occurs as the head undergoes internal rotation so that the occiput comes to lie behind the symphysis pubis. The neck rests under the pubic arch and normally the head is born by a movement of flexion. Arrest in the descent of the after-coming head may be due to unrecognized disproportion, the occipito-posterior position of the head, or to hydrocephalus. In most cases the head is brought into the pelvis by allowing the fœtal trunk to hang downwards for not more than one minute. Any failure of descent or difficulty in the delivery of the head indicates the necessity for immediate assistance. The body of the baby having been born and the placental circulation having been greatly diminished by the retraction of the uterus, efforts at respiration will almost certainly be made. If the birth of the baby is not completed within the next few minutes death from asphyxia is likely to take place. The obstetric forceps should be readily available for immediate use at every breech delivery, and the instrument should be used immediately to complete delivery whenever the descent of the head is arrested in the cavity of the pelvis. The usual method of application of the forceps is as follows. The body of the baby is lifted well upwards by an assistant and the blades are applied beneath the baby. The fingers of the right hand steer the left blade of the instrument into the left side of the pelvis and the application of the right blade is made in a similar manner. Satisfactory locking of the two blades together with approximation of the handles denote a correct application to the fœtal head (Fig. 126). Only moderate traction should be necessary to complete delivery as resistance from the pelvic floor has been removed by the episiotomy which has been performed and the birth canal has already been dilated by the birth of the body of the child.

Very occasionally the fœtal head cannot be made to enter the pelvic brim at all. Almost certainly there has been an error of judgment and pelvic contraction has been overlooked. Apart from the fact that the head may be lying transversely, flexion will almost certainly be poor, or absent, and the application of the forceps to the head at this level is always dangerous, unsatisfactory and exceedingly difficult. In the rare event of arrest occurring at this level assistance should be rendered in the following manner. One hand is passed in to the vagina behind the baby's thorax and a finger finds and presses on the jaw to produce flexion; the other hand is passed along the back until index and middle fingers curve over the shoulders to exert traction (Fig. 127). The head will be lying more or less in the transverse diameter of the brim, and it should be drawn through in this diameter by traction on the shoulders. As the head comes down into

the pelvic cavity it must be kept flexed and then rotated until the neck lies under the pubic arch. Delivery can then be completed by lifting the baby's trunk towards the mother's abdomen.

When delivering the after-coming head by traction on the baby's trunk, the possibility of causing injury to the baby must be borne in mind. Too strong traction on the shoulders may cause injury to the cervical spine, and

FIG. 126.   Forceps delivery of the after-coming head.

Illustration shows the position of the forceps and of the body of the baby during delivery of the after-coming head of breech presentation.

this injury is particularly likely to occur if the trunk is lifted upwards before the head has reached the pelvic floor. Forcible traction and rotation of the trunk may cause tearing and hæmatoma formation in the sterno-mastoid muscle, or the roots of the brachial plexus may be injured. This may cause complete paralysis of the arm, or an Erb-Duchenne palsy if only the fifth and sixth cervical roots are torn. Once the fœtal head has been directed through the brim and into the cavity of the pelvis, its delivery

should be completed with the obstetric forceps, especially if further descent presents apparent difficulty.

Difficulty at the outlet may occur if the outlet is contracted, or if the occiput has rotated posteriorly. Delivery again should be completed by the application of the obstetric forceps to the after-coming head. When the occiput lies posteriorly and cannot be rotated, the forceps must be applied in front of the baby's body which is supported by an assistant.

FIG. 127.   Delay in the pelvic cavity. Jaw flexion and shoulder traction.
The child's body rides on the left fore-arm. A finger passed into the mouth keeps the head flexed, while traction is applied to the shoulders by the first and middle fingers over the clavicles.

Finally the presence of a breech presentation may in certain circumstances constitute a clear indication for delivery of the baby by Cæsarean section. This treatment would especially be indicated in the case of a woman whose age is 35 or over and who is pregnant for the first time, or one who has previously been infertile or has had previous stillbirths.

Pelvic contraction, even if it is only mild, is an indication for Cæsarean section; any case in which the true conjugate is less than 10 cm. should be delivered by section.

Cæsarean section would usually be performed in cases associated with placenta prævia, and in cases of prolapse of the cord before full dilatation of the cervix.

Forcible extraction of the breech is no longer practised. Breech delivery, to be safe, should be easy and the labour should not be prolonged. A first

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stage of more than 24 hours or failure to expel the buttocks spontaneously in the second stage is likely to be followed by a difficult delivery and high fœtal risk, and Cæsarean section is more frequently performed in the interests of the fœtus.

Summary

Prevent breech delivery by external cephalic version in the antenatal period. Exclude pelvic contraction before embarking on breech delivery. Make an early diagnosis of prolapse of the cord by frequent vaginal examinations in labour. Confirm full dilatation of the cervix before encouraging bearing down efforts. After routine episiotomy under local anæsthesia await spontaneous expulsion of the buttocks. In the primigravida a rapidly induced general anæsthetic (for example with thiopentone) will increase the control and ease of delivery of the shoulders and head. Lövset's manœuvre is used to deliver the shoulders and forceps are applied to the aftercoming head.

OBLIQUE LIE AND SHOULDER PRESENTATIONS

When the fœtus lies with its long axis in the transverse axis of the uterus the lie is said to be transverse; when in an oblique axis of the uterus, the lie is said to be oblique. During the later weeks or pregnancy the latter is very much more common than the former. In cases of transverse and oblique lie the point of the shoulder is usually the presenting part, and after rupture of the membranes an arm may prolapse. The frequency of shoulder presentations is about one in 250 labours.

CAUSE

The commonest cause of an oblique lie is multiparity, associated with a lax abdominal wall. It is not infrequently found on antenatal examination some time before labour; prematurity is therefore a cause. An oblique lie may also be found with hydramnios or in twin pregnancy, and causes which interfere with engagement of the head, such as contracted pelvis, pelvic tumour or placenta prævia must always be considered. If a transverse lie occurs in a primigravida or recurs in successive pregnancies the possibility that it is due to a uterine malformation (arcuate or subseptate uterus) must be considered.

POSITIONS

The fœtus may lie with the head in either iliac fossa, the back sloping obliquely across the pelvic brim, whilst the breech usually occupies a somewhat higher position than the head, on the opposite side of the abdomen.

Only two positions are designated, dorso-anterior and dorso-posterior, the former being more common.
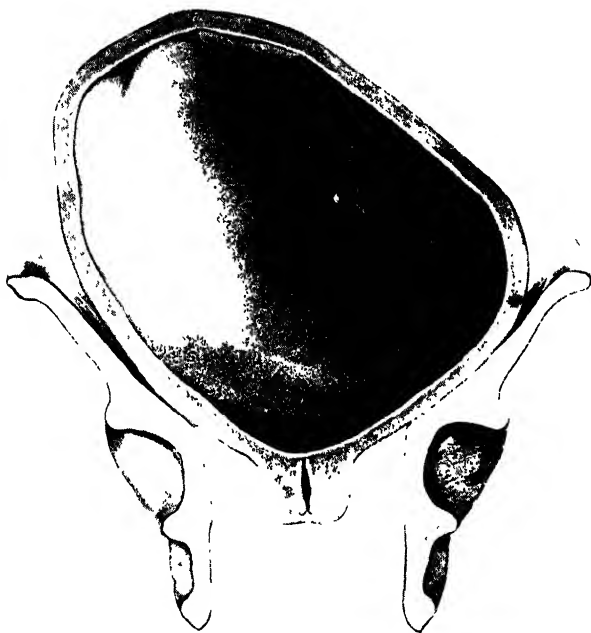
FIG. 128.   Shoulder presentation: dorso-anterior position.
The head is in the left iliac fossa, the back lies anteriorly and obliquely, and the breech is on the right above the right iliac fossa.

DIAGNOSIS

On abdominal inspection the uterus appears somewhat asymmetrical, being broader than usual, and the fundus not so high as would be expected for the duration of pregnancy. On palapation the hard round head will be felt in one iliac fossa, and the softer more irregular breech on the opposite side and at a somewhat higher level. The absence of any definite presenting part at the pelvic brim is an important diagnostic point. Across the middle of the abdomen the back will be felt in dorso-anterior positions, and small parts in dorso-posterior positions. The heart sounds are usually best heard just below the umbilicus (Fig. 128).

On vaginal examination during pregnancy or at the beginning of labour, the presenting part will be too high to be felt. During labour the membranes bulge in an elongated manner and generally rupture early. Before rupture an arm may be felt in the bag of membranes, and after prolapse of an arm often occurs, or a loop of cord may prolapse. Diagnosis of a shoulder

presentation depends on the recognition of the acromion process, scapula and ribs; if the shoulder has become œdematous it may be mistaken for a breech. A prolapsed arm must be distinguished from a leg; the elbow is sharper than the knee, and the absence of a heel and abduction of the thumb will distinguish hand from a foot. A diagnosis can be made of which hand has prolapsed by shaking hands with the prolapsed hand.
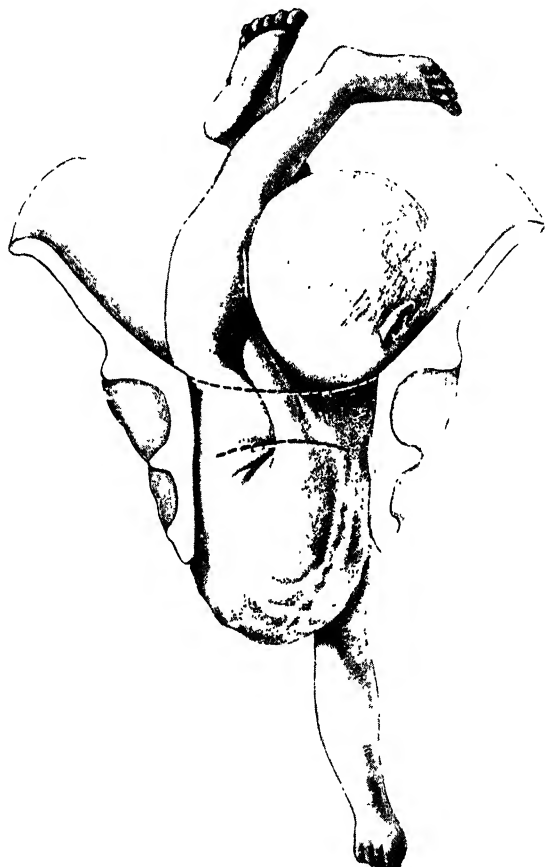
FIG. 129.   Spontaneous evolution.

The body is squeezed past the head by extreme flexion; the ribs distend the perineum, whilst the breech occupies the sacral hollow.

COURSE OF LABOUR

As the fœtus, lying obliquely, cannot be born naturally, unless it is very premature, there is no true mechanism of delivery, and an untreated case will end in obstructed labour and fœtal death.

Spontaneous rectification to a vertex or more rarely a breech may sometimes occur in early labour, but cannot do so after prolapse of an arm.

Spontaneous delivery in a neglected shoulder presentation may occasionally occur with a very premature fœtus which is usually stillborn. With forcible and prolonged uterine action, the shoulder may appear at the vulva, and be followed by the trunk, breech and finally the head. (Spontaneous evolution, Fig. 129.) Or the fœtus may be delivered doubled up, with the chest and pelvis pressed together, followed by the head and limbs. (Spontaneous expulsion, Fig. 130.)

FIG. 130.   Spontaneous expulsion.

Delivery of a premature or macerated fœtus by doubling and compression of the body.

PROGNOSIS

A shoulder presentation in a primigravida is particularly serious because of the causes which interfere with engagement of the head, such as contracted pelvis, pelvic tumours or placenta prævia. These conditions are likely to cause difficulty or obstruction in labour even though the malpresentation can be rectified. Furthermore the necessary manipulations during labour are more difficult in a primigravida.

In a multipara a shoulder presentation is commonly due to a lax abdominal wall, and the prognosis depends on early recognition of the malpresentation. The prognosis is good if a vertex presentation can be obtained

when labour begins. If a shoulder is presenting at the onset of labour, the membranes are likely to rupture early, with prolapse of an arm and possibly a loop.of cord; internal manipulations and delivery as a breech will then increase the risk to both mother and fœtus.

Neglected shoulder presentations are extremely serious, since all the risks of obstructed labour are present, including rupture of the over-distended lower uterine segment and possible infection of the uterus and fœtus; in the case of the fœtus, death is usual from interference with the circulation in the placental-site.

TREATMENT

Before labour. During pregnancy an oblique lie should be corrected by external cephalic version to a vertex presentation (p. 370). A careful investigation must be made for a cause, such as contracted pelvis, pelvic tumour or placenta prævia, which may be interfering with the engagement of the head, and may perhaps necessitate Cæsarean section. The malpresentation is liable to recur, and frequent abdominal examinations are advisable. After the 38th week it may be permissible to rupture the membranes after version and to initiate labour with an oxytocin drip, but it is better to ensure that the patient is examined at the onset of natural labour, so that the presentation can be finally rectified if necessary, and the vertex presentation subsequently maintained.

Early in labour. With efficient antenatal supervision, an oblique lie should not be found at the time of the onset of labour, but if present it may still be corrected by external cephalic version if the membranes are intact. Once the oblique lie has been rectified the uterine contractions will assist in maintaining the longitudinal lie, especially if the membranes are then ruptured.

If it is not possible to obtain a longitudinal lie the delivery is best completed by Cæsarean section performed through a longitudinal incision made low down on the uterine wall.

Advanced labour. Occasionally the membranes may remain intact until the cervix is almost fully dilated. Under these circumstances it is permissible to rupture the membranes and to perform internal podalic version and complete the delivery by immediate half-breech extraction. However, it is not justifiable to perform internal version at half dilatation and then to pull down a leg and await spontaneous breech delivery. This manœuvre results in a high fœtal mortality; as the patient recovers from the general anæsthetic she will attempt to expel the fœtus before full dilatation of the cervix, and this may result in trapping of the after-coming

head and fœtal death from anoxia. Traction on the fœtal legs will cause it to take deep inspiratory gasps of liquor amnii. Cæsarean section is preferable if the cervix is not fully dilated.

Late in labour, when the shoulder has become impacted (Fig. 131). In neglected cases when the uterus is verging on tonic retraction, i.e. when every attempted manipulation within the uterus is resisted, there is the gravest danger in attempting any form of version, owing to the very great
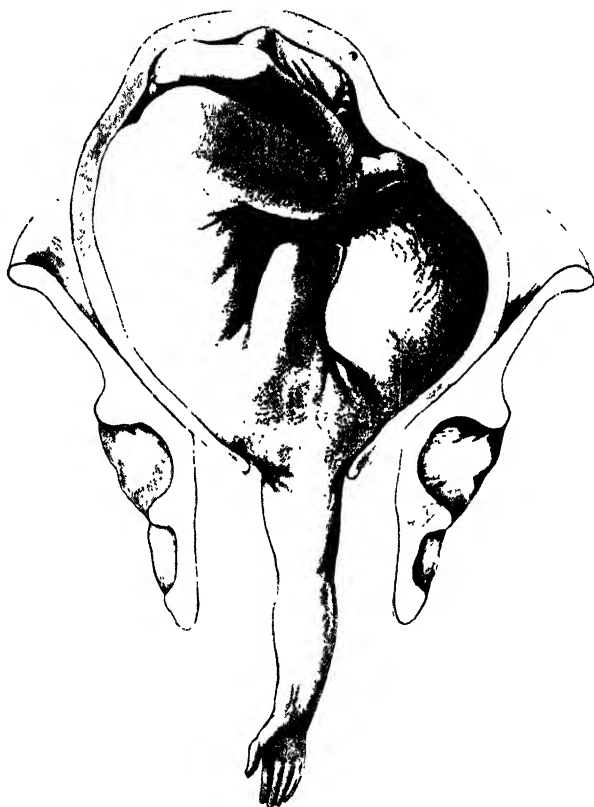
FIG. 131.   Shoulder presentation with prolapse of arm.

The shoulder and arm, forming the apex of the wedge, are driven into the brim; the head and neck on the one side and the trunk on the other form the sides of the wedge.

risk of rupturing the thinned lower uterine segment. If the fœtus is alive, a lower segment Cæsarean section may be considered if conditions are suitable, but almost invariably the fœtus will have perished from the interference with the circulation of the placental site, due to the tonic retraction

of the uterus, and therefore only the mother's safety requires consideration.
The usual method of delivery in such a case is by decapitation. This
requires deep general anæsthesia, and is a somewhat difficult procedure,
associated with high maternal morbidity. In the hands of the skilled oper-
ator decapitation is most easily performed with the Blond-Heidler saw
(see p. 543).

COMPLEX PRESENTATIONS

Prolapse of the limbs occurring with a vertex presentation is known as a
complex presentation. Commonly it is the hand which comes down, rarely
the foot, and very occasionally hand and foot.

FIG. 132.   Complex presentation.
Prolapse of arm with vertex presentation.

Prolapse of an arm occurs under much the same conditions as prolapse
of the umbilical cord; with a small premature head in a large pelvis, or
under conditions in which the head does not fit the brim properly, such as
a flat pelvis (Fig. 132).

TREATMENT

If the head is not low in the cavity, it will often be found that the arm
goes back as the head descends, and active treatment is not required. If the
head is small and the pelvis capacious, there may be room for the head to

pass even if the arm remains down. If the progress of the head is arrested the arm should be replaced under anæsthesia, and the head then pressed down into the brim. Delivery may be completed by forceps if the cervix is fully dilated. The possibility of disproportion should be remembered when the head is found fixed in the brim.

When a foot presents with the head, it may be pushed up under anæsthesia, or it may be better to pull on the foot and push up the head, turning the fœtus into a footling presentation. When the head is low in the pelvis, the forceps should be applied to the head and the foot pushed up out of the way. When the hands and feet come down together, the legs should be brought down, and the fœtus delivered as a breech.

PRESENTATION AND PROLAPSE OF THE UMBILICAL CORD

DESCENT of the umbilical cord below the presenting part occurs about once in 300 births, and constitutes a grave risk to the fœtus because of the danger of impairment of the circulation in the umbilical cord vessels.

Three clinical types of descent are described:

1. *Presentation*, when the umbilical cord lies below the presenting part in the intact bag of membranes (Fig. 133).

FIG. 133.   Presentation of the cord.

2. *Prolapse*, when the cord descends below the presenting part when the membranes rupture.

3. *Occult prolapse*, when the cord lies beside the head, but cannot be felt easily on vaginal examination. This may cause fœtal distress, the cause of which is not evident at the time.

CAUSES

Descent of the umbilical cord is more likely to occur when the presenting part does not completely occupy the lower segment of the uterus; in normal

labour the well-flexed vertex engages before the onset of labour or soon after, and tends to prevent prolapse of the cord.

Prolapse of the cord is therefore particularly likely to occur as a complication of malpresentations such as flexed breech or shoulder presentations, and occasionally with a brow, face or even an occipito-posterior position of the vertex. Nevertheless it occurs with a normal vertex presentation in over half the cases, and is more likely to occur when the head is free above the pelvic brim. Excess of liquor amnii, by permitting greater mobility of the fœtus, tends to produce malpresentation, and when the membranes rupture a sudden gush of liquor may carry a loop of cord down into the vagina.

Prolapse of the cord is more likely to occur with a premature or small fœtus, and is often a complication of labour with twins. Contracted pelvis is an important cause of prolapse of the cord, and in the rachitic pelvis the space on either side of the engaging head favours its occurrence. Contracted pelvis due to rickets has become a rarity, and is not often found nowadays as a cause of prolapsed cord, but it must always be looked for, and the pelvis carefully examined in every case.

In some cases of descent of the umbilical cord the cord is unduly long, and there is little doubt that excessive length is an important cause. Low implantation of the placenta, placenta prævia, will also facilitate descent, but this is not often found.

<div align="center">DIAGNOSIS</div>

Presentation of the umbilical cord is seldom discovered. This may be because it is less common then prolapse of the cord, and also because patients are not invariably examined vaginally at the onset of labour, and even if so examined, the condition may easily be missed, particularly if the presenting part is high. Nevertheless a presenting cord can be felt through the intact bag of membranes and pulsation of the cord vessels should be recognized. Pulsation may also be felt in vasa prævia, in which there is a velamentous insertion of the cord, and the velamentous portion crosses the membranes covering the internal os. Slowing of the fœtal heart has been recorded when the head is pushed into the pelvic brim in presentation of the cord, but slowing may also be observed in placenta prævia, or in vasa prævia, or in the absence of any abnormality, simply as a result of compression of the fœtal head. Presention of the cord may be recognized on examination prior to surgical induction of labour, when the operation should of course be abandoned.

In prolapse of the cord the diagnosis presents no difficulty as a loop of cord is felt in the vagina, and may even present at the vulva. It should be a rule that every patient is examined vaginally as soon as possible after rupture

of the membranes, whether she is having contractions or not, in order to exclude or diagnose prolapse of the cord. The loop of the cord should be palpated to see if pulsations are present, but it must be remembered that even if the cord is compressed so that pulsations are absent, the fœtus may yet be alive, and fœtal heart sounds audible on ausculation of the abdomen.

Whenever presentation or prolapse of the cord is diagnosed, the degree of dilatation of the cervix should be noted, and the cause sought. The diagnosis of twins, malpresentation or contracted pelvis should be considered.

PROGNOSIS

Presentation or prolapse of the cord does not in itself increase the risk to the mother, except for the slightly increased risk associated with complications such as twins, malpresentation or contracted pelvis, if present, but descent of the cord often calls for speedy delivery by forceps, breech extraction or by Cæsarean section, in order to save the child, and these procedures inevitably increase the maternal risk to some extent.

The prognosis for the fœtus in presentation or prolapse of the cord is grave; stillbirth or neonatal death occurs in about 20 per cent of cases. It is said that the prognosis is worse when the head presents as it is more likely to compress the cord, but it can also be compressed by a breech presentation; in a shoulder presentation there is more chance that the cord will escape compression.

The prognosis for the fœtus has been improved in recent years by the more frequent use of Cæsarean section in cases of prolapse of the cord when the cervix is not fully dilated.

TREATMENT

Treatment depends on whether the fœtus is alive or dead, and on the dilatation of the cervix, and will be considered under these headings:
1. With an incompletely dilated cervix, and a live fœtus.
2. With an incompletely dilated cervix, and a dead fœtus.
3. With a fully dilated cervix.

1. With an incompletely dilated cervix and a live fœtus

(a) *Cæsarean section.* In a case of presentation or prolapse of the cord, if the cervix is not fully dilated, the best chance of getting a live child is by Cæsarean section. This should be undertaken immediately. In every maternity unit the theatre should be ready for emergency Cæsarean section at short notice. If the membranes have not already ruptured, nothing should be done which might cause them to rupture, as the intact bag of membranes makes it unlikely that compression of the cord will occur.

If pulsation is not felt in a prolapsed cord it must not be assumed that the fœtus is dead. If the cord has only been compressed for 5 or 10 minutes the fœtal heart may still be heard on auscultation, and immediate steps must be taken to relieve the compression of the cord. This may be achieved by the knee-chest position, which tends to keep the presenting part out of the pelvis, thus relieving compression (Fig. 134). This position causes the
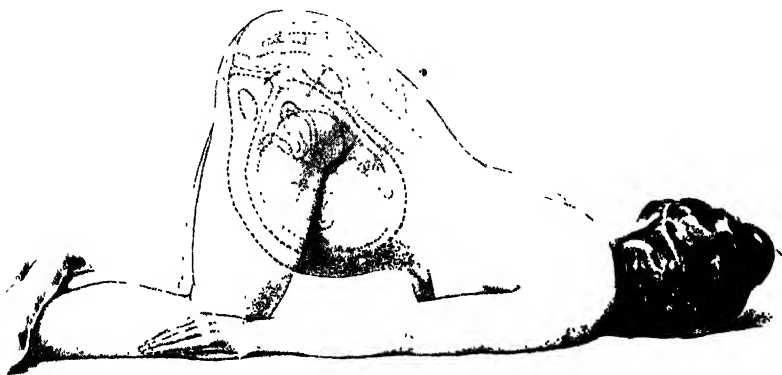
FIG. 134.   The knee-chest position in the treatment of presentation of the cord. In this position the cord tends to sink towards the fundus and the presenting part to leave the brim; thus the risk of pressure on the cord is diminished.

patient considerable discomfort, and if used should not be continued for more than ten minutes. A steep Trendelenberg position on the operating table has a similar effect. A more practical method is to push the presenting part up above the brim by digital pressure from the vagina, and to maintain it there by upward pressure with a hand above the symphysis pubis; this is helped by blocking the foot of the bed, and auscultation of the fœtal heart will confirm that compression has been relieved. One of these methods should be used whilst preparations for Cæsarean section are being made, even if the cord is found to be pulsating.

(b) *Replacement of the cord.* The only alternative if Cæsarean section cannot be performed at once in cases in which the cervix is not fully dilated is to replace the prolapsed cord above the presenting part. This may be attempted by wrapping the loop of cord loosely in sterile gauze, and then pushing it up above the presenting part. With any method of replacement the prognosis for the fœtus is poor. The cord often prolapses again, or being incompletely replaced remains compressed. Manipulation of the cord and the effect of cold air causes spasm of the cord vessels which impairs the circulation even if the cord is not actually compressed.

2. With an incompletely dilated cervix and a dead fœtus

If the cervix is not fully dilated and the fœtal heart cannot be heard it must be presumed that the fœtus is dead. Cæsarean section is not justified and there is no indication for interference so far as the prolapsed cord is concerned. Sedative drugs should be given and the labour allowed to proceed, unless a shoulder presentation or a contracted pelvis necessitates intervention.

3. With a fully dilated cervix ,

If the cervix is fully dilated when prolapse of the cord is first discovered, and this is not at all uncommon, then immediate vaginal delivery is indicated, without attempting to replace the prolapsed cord. Delivery should be effected by forceps if the head presents, or by breech extraction if a breech. If a prolapsed cord is found with a shoulder presentation, internal version and breech extraction are required, but the danger of rupturing the lower segment must be remembered, and Cæsarean section is preferable if there is any question of tonic retraction of the uterus.

With a fully dilated cervix immediate delivery is advisable, even if pulsation cannot be felt in the cord; it may yet be possible to resuscitate the child. Facilities for the treatment of asphyxia, including an inclined plane, endotracheal tube and special oxygen flowmeter, should be available in every labour ward, and should be in readiness whatever method of treatment has been carried out for a prolapsed cord.

CLASSIFICATION OF PELVIC TYPES
AND OF PELVIC ABNORMALITIES

THE size of the female pelvis is of primary importance, because if it is large enough there will be no mechanical difficulty associated with the passage of the fœtal head through it. The *shape* of the pelvis is of secondary import and only has a bearing on mechanisms of labour and ease of delivery if the pelvic dimensions are small in relation to those of the fœtal head passing through it.

(i) *Brim*

(ii) *Lateral View*   (iii) *Outlet*
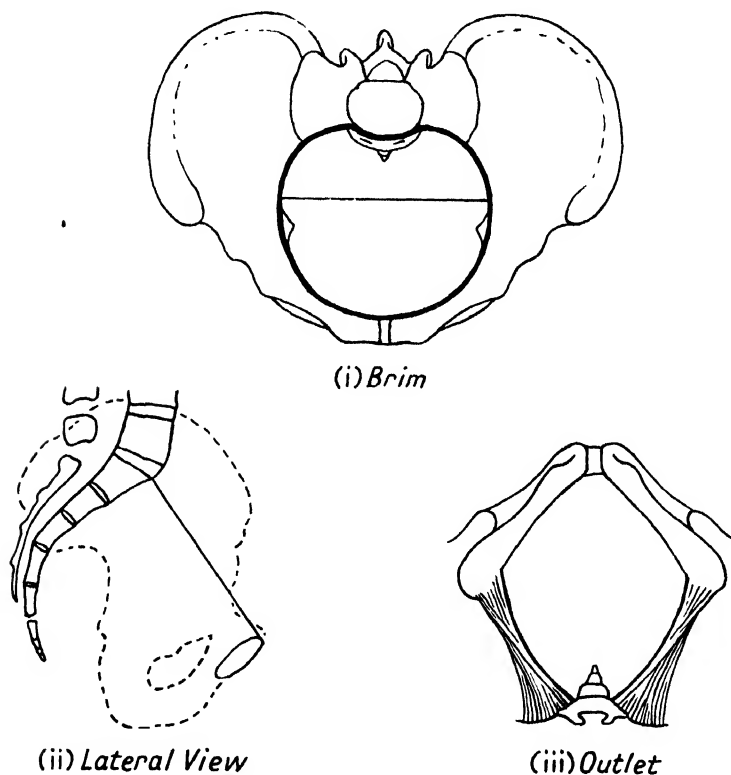
FIG. 135.   The gynæcoid pelvis.

Certain terms are used to describe variations in the shape of the pelvis which may be discovered by radiological study.

The various types of pelvis to be described serve as a useful basis for understanding the subject, but clinical experience shows that very few

pelves fit the criteria exactly. Each pelvis tends to be a mixture of two or more of the types and they may vary at different levels of the same pelvis. For example, the anterior half of the brim of a pelvis may be beaked as in the android pelvis, while the posterior half may be rounded, or gynæcoid.

A brief description of each type of pelvis follows with diagrams to show the shapes of the brim, of the cavity (lateral view) and of the outlet.

1. *The gynæcoid pelvis* conforms to the accepted female type in that the brim is rounded, with the widest transverse diameter slightly behind its

(i) *Brim*

(ii) *Lateral View*

(iii) *Outlet*
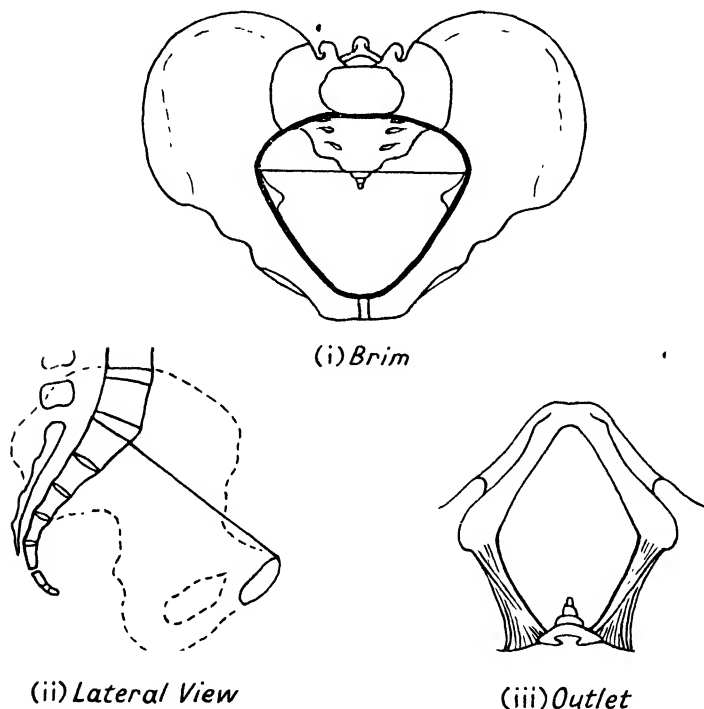
FIG. 136. The android pelvis.

centre (Fig. 135). The average dimensions of the brim are antero-posterior diameter 11·2 cm. (4½ in.) and transverse diameter 13·2 cm. (5¼ in.). The sub-pubic arch is rounded, with an angle of at least 90 degrees. Labour proceeds normally once the head has engaged.

2. *The android pelvis* has many characteristics of the male pelvis. The brim is heart-shaped so that the widest transverse diameter is much nearer the sacrum than it is in the gynæcoid pelvis (Fig. 136). The average dimensions of the brim are antero-posterior diameter 10·2 cm. (4 in.) and transverse diameter 12·9 cm. (5 in.). The side walls tend to converge, and

the sub-pubic arch is usually narrow, with an angle of 60 or 70 degrees. Both the antero-posterior and transverse diameters of the outlet average 10·2 cm. (4 in.). This type of pelvis is often funnel-shaped with diameters which decrease from above downwards, disproportion thus becoming worse as labour proceeds.

3. *The anthropoid pelvis*. The antero-posterior diameters of brim and outlet exceed the transverse diameters (Fig. 137). The average dimensions

(i) *Brim*

(ii) *Lateral View*

(iii) *Outlet*
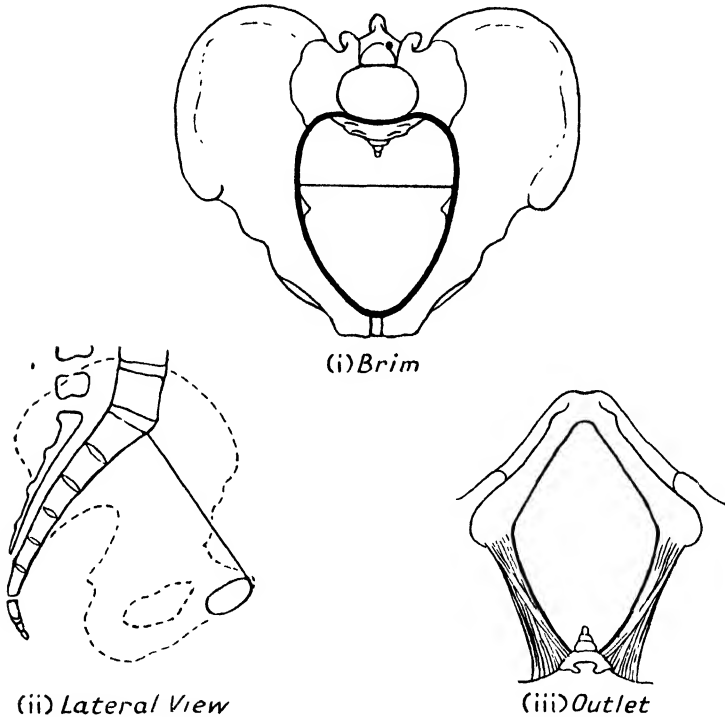
FIG. 137. The anthropoid pelvis.

of the brim are antero-posterior diameter 12·8 cm. (just over 5 in.), and transverse diameter 12 cm. (4¾ in.). The pelvis tends to be deep and the sacrum frequently has six segments instead of five. This is known as a high assimilation pelvis. Very often the sacrum and the axis of the pelvic cavity are straighter or less curved than in the gynæcoid pelvis. The sacro-sciatic notch is wide and the sub-pubic arch tends to be narrow, about 70 degrees, but the antero-posterior diameter of the outlet averages 12·6 cm. (5 in.). Labour is normal once the head has engaged, but because of the roomy posterior half of the pelvis occipito-posterior positions are common.

4. *The platypelloid pelvis* is the simple (non-rachitic) flat pelvis. The brim is elliptical with a wide transverse diameter (Fig. 138). The average dimensions of the brim are antero-posterior diameter 10·6 cm. (4½ in.), and transverse diameter 14·3 cm. (5¾ in.). The sub-pubic arch is wide and rounded as a rule, measuring 90 to 100 degrees. Once the head has negotiated the brim there is usually no difficulty in a flat pelvis. The process of

(i) *Brim*

(ii) *Lateral View*   (iii) *Outlet*
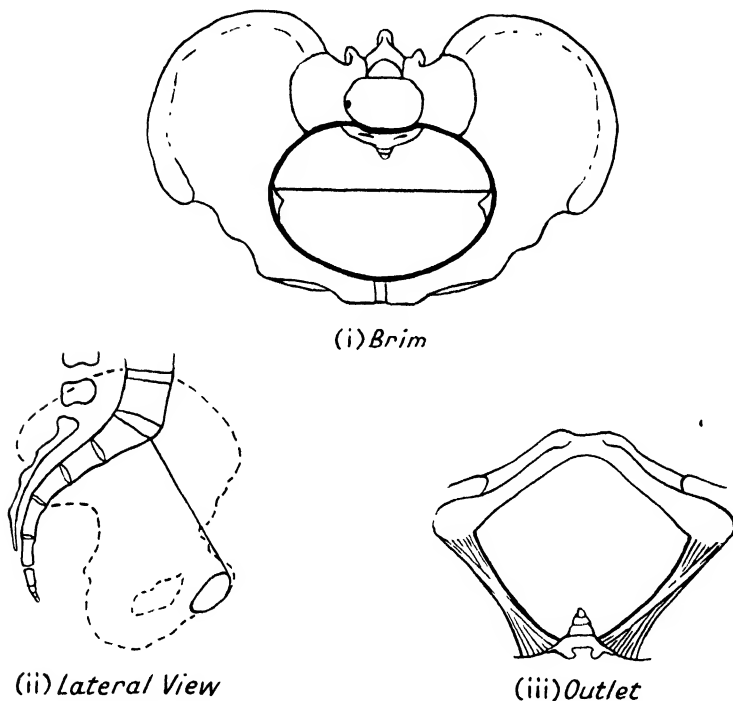
FIG. 138.   The platypelloid pelvis.

negotiating the brim which seems too small is by a sideways tilt of the head so that one parietal bone presents as it passes through the brim. This is known as anterior or posterior asynclitism according to the direction of the tilt (see p. 412).

It must be emphasized that these variations in shape have little effect on the normal mechanism of labour unless there is considerable reduction in any of the pelvic measurements. The rounded gynæcoid pelvis is perhaps the most favourable shape, and the android pelvis is the least favourable to a normal mechanism because of the tendency to contraction of the outlet. The anthropoid pelvis favours engagement of the head in the antero-posterior diameter of the brim, and if it engages as an occipito-posterior it

may fail to undergo internal rotation, and be delivered face to pubis. The platypelloid pelvis favours engagement of the head in the transverse diameter of the brim.

Abnormalities of the pelvis may be classified into three groups:

1. *Developmental*
    Small gynæcoid, generally contracted, or small round pelvis.
    Small android, male or funnel-shaped pelvis.
    Small anthropoid pelvis.
    Small platypelloid or simple flat pelvis.
    The oblique pelvis of Nægele.
    The transversely contracted pelvis of Robert.
    The high assimilation pelvis.
    The low assimilation pelvis.

2. *Disease or injury of the pelvic bones*
    The rachitic flat pelvis.
    The osteomalacic pelvis.
    Fractured pelvis.
    New growths of the pelvic bones.

3. *Abnormalities of the spine, hip joints and lower limbs*
    The kyphotic pelvis.
    Spondylolisthesis.
    Hip disease, including congenital dislocation of the hip.
    Defect of one leg, causing tilting of the pelvis.

1. Developmental abnormalities. This group includes the small gynæcoid or generally contracted pelvis, the small android or funnel-shaped pelvis, the small anthropoid pelvis and the small platypelloid or simple flat pelvis. The presence of a sixth segment in the sacrum which may be found with an anthropoid pelvis has given rise to the term high assimilation pelvis, but these developmental anomalies are not in themselves of any great significance. Very rarely malformation of the pelvis may result from defective development of one side of the sacrum, which is fused with the ilium. This is known as the oblique pelvis of Nægele, and if bilateral is known as the transversely contracted pelvis of Robert.

2. Disease or injury of the pelvic bones. Distortion of the pelvis may be caused by mal-united fractures or by new growths arising from pelvic bones. The most important abnormality in this group is rickets, which causes softening of the pelvic bones and rachitic deformity in early

life. Fortunately the disease is becoming uncommon in this country. A similar disease, osteomalacia, which may occur in adults, can cause very severe distortion of the pelvis; it is almost unknown in Britain, but may still occur in Africa and Asia.
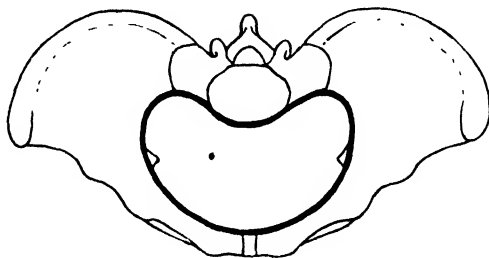
(i) *Brim*

(ii) *Lateral View*
(*Showing forward displacement of the sacral promontory*)

FIG. 139.   Rachitic pelvis.

3. Abnormalities of the spine, hip joints and lower limbs. The shape and inclination of the pelvis may be markedly affected by kyphosis of the spine or by spondylolisthesis. Disease of the hip joints, particularly congenital dislocation and abnormalities of the lower limbs which affect the distribution of the body-weight, and cause tilting of the pelvis, may give rise to an oblique distortion of the pelvis. As scoliosis is usually present under these conditions, it is often referred to as the scoliotic pelvis, but pelvic obliquity is not caused by the scoliosis, and is only likely to occur if the condition was present before the completion of bone growth, about 17 or 18 years.

The generally contracted or small round pelvis

This corresponds to the small gynæcoid pelvis, and is usually found in small women, but may also occur in women of normal stature. The diagnosis will be made by the small external pelvic measurements, and by a proportionate reduction in all pelvic diameters (Fig. 140).
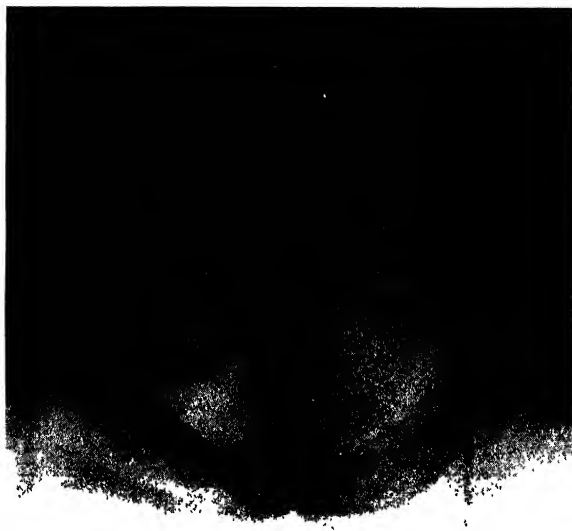
FIG. 140.   The generally contracted or small round pelvis; X-ray of inlet.

Mechanism of labour

In many cases the mechanism of labour is quite unaffected because the size of the fœtal head at term is also small, and a birth-weight of about 6 pounds is common. Disproportion may, however, occur, and the head may not engage until the first stage of labour. Extreme flexion of the head and excessive moulding may occur.

First stage. The brim may be too small to admit the head, but as the brim is rounded the head is not forced out to one side, as it may be with a flat pelvis. As the head fits into the brim tightly it cuts off the hind-waters from the fore-waters, and therefore premature rupture of the membranes or prolapse of the cord is unlikely to occur. With strong contractions the lower segment may be compressed against the brim, giving rise to œdema of the cervix, which fails to dilate if labour becomes obstructed. Malpresentations are uncommon, but the head has to undergo marked flexion, and there is usually a large caput succedaneum and extreme moulding (Fig. 141).

Second stage. Although the outlet is small delivery of the head may not be unduly difficult as it has become well moulded, during its passage through the brim. There is often some delay in the second stage, and forceps delivery may be necessary because of maternal or fœtal distress. Difficulty may also be experienced with the delivery of the shoulders.

The after-coming head in breech delivery should also come through the pelvis with good flexion, but there is more likely to be difficulty with extended arms than with the after-coming head in this type of pelvis; the limited space available for internal manipulations makes breech delivery hazardous in a generally contracted pelvis.
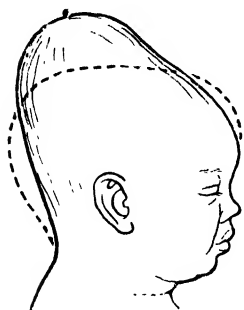
FIG. 141. Moulding and caput formation resulting from small round pelvis.

The small android or funnel-shaped pelvis

It has already been noted that this type of pelvis is least favourable to the normal mechanism of labour, because of a tendency to contraction at the pelvic outlet. If all the pelvic measurements are small, or if there is marked convergence of the side walls of the pelvis with perhaps an inwardly projecting sacro-coccygeal shelf, there is likely to be a prolonged second stage, and there may be considerable difficulty in delivery. Severe degrees of contracted outlet are fortunately rare. With less severe degrees of contraction the difficulty can usually be overcome because of the fact that the antero-posterior diameter of the outlet is capable of being stretched. As a rule the sacro-coccygeal joint allows some backward displacement of the coccyx, and the sacrum, which is joined to the ischium by the sacro-sciatic ligaments, can undergo a limited degree of backward rotation. Nevertheless, the results of forcible forceps delivery to overcome outlet disproportion can be disastrous, and careful ante-natal examination of the outlet should never be neglected (Figs. 142 and 143).

Mechanism of labour

First stage. Although engagement of the head may be delayed until the first stage of labour because of the heart-shaped pelvic brim, actual obstruction at the brim rarely occurs with an android pelvis. Malpresentations, particularly posterior positions of the occiput, are, however, likely to occur because the widest diameter lies in the posterior segment of the brim.

Second stage. Strong expulsive efforts may complete the normal mechanism of labour and result in spontaneous delivery, but the head will have

undergone considerable moulding and compression, and the perineum may be extensively torn, because the narrow sub-pubic arch forces the head to emerge more posteriorly than usual.

FIG. 142. Android pelvis; X-ray of inlet, showing heart-shaped brim and prominent ischial spines.

FIG. 143. Android pelvis; view of supubic arch.

More often the second stage is prolonged, and forceps delivery is required. As a rule the head is held up in the pelvic cavity in the region of

the ischial spines; it may be badly flexed, and usually lies transversely in the position known as deep transverse arrest. Occasionally the head is found impacted in the pelvis with the occiput posterior. Flexion and manual rotation of the head must precede the application of the obstetric forceps, and even then undue force may have to be used to effect delivery. An episiotomy should be performed to avoid a third degree perineal tear, but extensive laceration of the vaginal walls may occur laterally.

Fœtal distress may arise from a prolonged second stage, and intracranial hæmorrhage may result from excessive compression of the fœtal head during delivery. Delivery of the after-coming head in a breech presentation through a contracted outlet is particularly unfavourable.
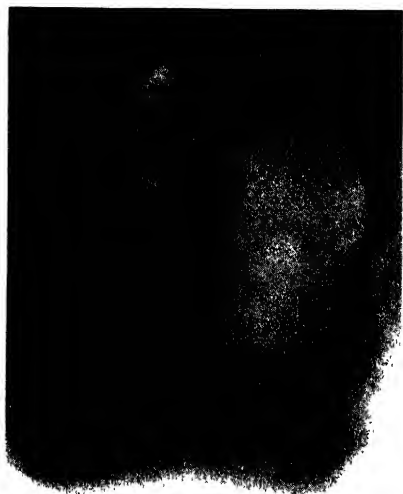
FIG. 144. Anthropoid pelvis; X-ray of inlet, showing long antero-posterior diameter.

FIG. 145. Anthropoid pelvis; lateral view, showing six segments in sacrum.

The small anthropoid pelvis

In this type of pelvis also the head may fail to engage before labour in a primigravida, and it will tend to engage in the antero-posterior diameter of the brim. Disproportion between the biparietal diameter and the transverse diameter of the brim is almost unknown, and difficulty is only likely to occur at the pelvic outlet if the head has engaged with the occiput posterior. Internal rotation may fail to occur because the anthropoid pelvis

has not a marked pelvic curve, and a persistent occipito-posterior position results. Manual rotation of the head may be difficult because of the narrow transverse diameter of the pelvis (Figs. 144, 145). In this case the head should be delivered in the occipito-posterior position.

The small platypelloid or simple flat pelvis

This type of pelvis is not very common, and may be difficult to distinguish from a mild degree of rachitic deformity. Disproportion may occur at the pelvic brim if the antero-posterior diameter is unduly small, and the clinical effects and mechanism of labour are similar to those described in the next section on the rachitic flat pelvis (Fig. 146).

FIG. 146. Simple flat or platypelloid pelvis; view of inlet.

The rachitic flat pelvis

Marked degrees of rachitic deformity of the pelvis have become very rare owing to the prevention and treatment of rickets in early life. The characteristic rachitic deformities are produced in infancy as a result of softening of the bones due to vitamin D deficiency. The body-weight, transmitted through the spine and pelvis, tends to rotate the sacrum forwards, and to cause flattening of the brim, the transverse diameter becoming larger and the antero-posterior smaller than normal. (Fig. 139).

In marked cases the sacral promontory projects forwards, still further diminishing the true conjugate diameter, and the brim becomes kidney-shaped or reniform. In some cases the lower margin of the first sacral

FIG. 147. X-Ray showing gross pelvic deformity, probably due to rickets.

FIG. 148. Rachitic pelvis; lateral view, showing disproportion at the brim.

segment projects further forwards than the true promontory, and the conjugate should be measured from it rather than from the true promontory. The side walls of the rachitic pelvis tend to diverge and the pelvic outlet is usually wide (Figs. 147 and 148).

Diagnosis. A rachitic pelvis may be suspected if it is known that the patient spent her childhood in a part of the country where malnutrition and poor living conditions are still present, and if, in addition, signs of rickets are found. Shortness of stature, kyphosis of the spine, and bowing of the legs are characteristic, but the bossed head and rachitic rosary are not often seen now.

On vaginal examination the sacral promontory may be easily felt and the diagonal conjugate may be considerably less than normal, but the transverse diameter of brim and outlet are usually increased.

In early pregnancy incarceration of the retroverted gravid uterus may occur because of the overhanging sacral promontory. In the later months the presenting part is found to be freely movable above the brim, and if it is a cephalic presentation the head cannot be made to engage. Malpresentations are likely to occur. Finally, the diagnosis of a rachitic pelvis may be made by X-ray studies, undertaken because of clinical evidence of disproportion at the brim.

Mechanism of labour. The head does not enter the brim easily, and may even be displaced into one or other iliac fossa. Because the head does not accurately fit the distorted brim, elongation of the bag of membranes and premature rupture of the membranes are likely to occur, and sometimes a loop of cord prolapses alongside the head. There may be considerable delay in the first stage of labour because the head fails to pass through the brim. The cervix does not dilate easily because the head does not come down to stretch it, and it will become œdematous because the head compresses the lower uterine segment against the symphysis pubis and sacral promontory.

Difficulty at the pelvic brim in a rachitic pelvis may be overcome by strong uterine contractions, and this will be aided by moulding of the fœtal head, but the following points should be noted in the mechanism:

1. The head engages in the transverse diameter of the brim rather than in an oblique diameter.

2. The head is displaced laterally so that the occiput and biparietal diameter ($9 \cdot 3$ cm. or $3\frac{3}{4}$ in.) can descend to one side of the sacral promontory, the bitemporal diameter ($8 \cdot 1$ cm. or $3\frac{1}{4}$ in.) passing through the true conjugate. If the biparietal diameter becomes fixed in the mid-line of the brim the head may very rarely become extended to produce a brow or face presentation, but this will not aid the mechanism.

3. The transverse diameter of the fœtal head from a point just below one parietal eminence to a point just above the other is rather less than the biparietal diameter, and is called the *subparieto-supraparietal diameter*. Most commonly the anterior parietal bone descends first, the head tilting towards the posterior shoulder. This is known as anterior parietal presentation, Nægele's obliquity or posterior asynclitism (Fig. 149). When the anterior parietal eminence has descended past the symphysis, the posterior parietal eminence is forced past the sacral promontory by tilting of the head towards the anterior shoulder. Posterior parietal presentation or anterior asynclitism occurs infrequently, and is less favourable than Nægele's obliquity.

FIG. 149. Anterior parietal presentation or Nægle's obliquity.

Once the head has passed through the contracted brim of a rachitic pelvis the normal mechanism of flexion and internal rotation should follow. As a rule the outlet is wide in all diameters, and delivery of the head may be quite easy.

With the after-coming head of a breech presentation the mechanism of labour is similar, but the tendency to extension of the head will be greatly increased by traction on the fœtus, so that the head will become fixed in the brim, and greatly diminish the chances of delivering a live child. Although internal podalic version has, in the past, been practised for a contracted brim, the prognosis is, in fact, far less favourable for a breech than for a vertex presentation.

Effects on mother and child. Direct injury to the cervix, vaginal vault and bladder may be caused by the high forceps operation in a woman

with a rachitic pelvis. If the head has been allowed to mould its way slowly through the brim there may also be considerable damage to the maternal tissues from pressure necrosis, and a vesico-vaginal fistula may appear a week or ten days after delivery, from sloughing of the tissues.

Considerable moulding of the head is likely to occur (Fig. 150), and intracranial hæmorrhage may cause death of the fœtus during labour, or neonatal death. An abrasion may sometimes be seen over one or other parietal bone where it has been forced past the sacral promontory, and occasionally a spoon-shaped depression may be found in one parietal bone, where it has been indented by the promontory.

FIG. 150.   Fœtal head after long labour with a rachitic pelvis.

The parietal bone which was posterior has become somewhat flattened and its upper edge has been pushed under the anterior parietal bone. A caput succedaneum has formed over the latter.

The osteomalacic pelvis

Osteomalacia is also a deficiency disease, accompanied by marked softening of the bones. The pelvic deformity may be extreme, both acetabula and the sacral promontory being pushed inwards to form a triradiate pelvis, through which delivery of the fœtus is quite impossible. Osteomalacia may occur in adults as well as in children, but fortunately it is becoming of historical interest only (Fig. 151 and Fig. 152).

FIG. 151. Pelvis from a patient with osteomalacia. Note the crumpling of the bones causing great distortion of the pelvis.

Brim
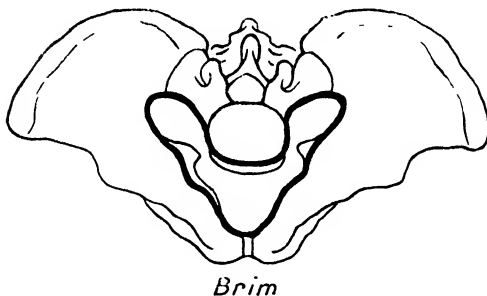
FIG. 152, Osteomalacic or triradiate pelvis.

The kyphotic pelvis

Pelvic deformity may be produced by kyphosis of the spine, if this occurs before puberty. If the kyphosis is in the upper part of the spine a compensatory lordosis is developed below, and the pelvis is not affected. If the kyphosis is in the lower dorsal or lumbar region the top of the sacrum is displaced backwards, and the lower part forwards. The result is an increase in the antero-posterior diameter of the brim, but the antero-posterior

diameter of the outlet is reduced. There may also be some narrowing of the transverse diameter of the outlet, and the effect on the mechanism of labour is similar to that in the android or funnel-shaped pelvis (Fig. 153).
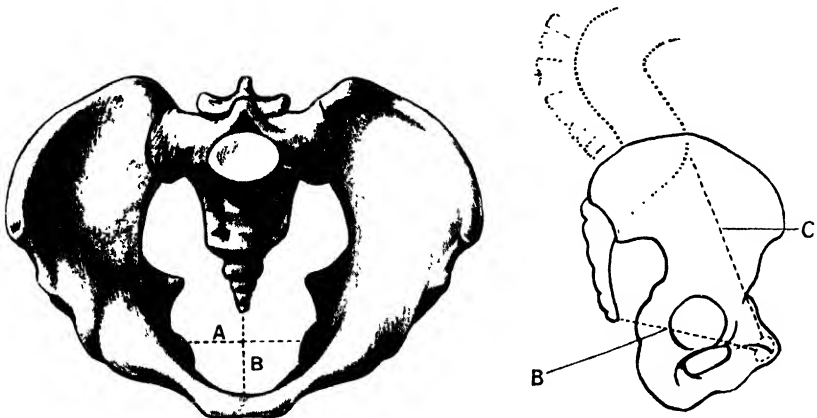
FIG. 153.   Kyphotic pelvis.

Showing the diminished antero-posterior (B) and transverse (A) diameters of the outlet, and the increased antero-posterior diameter (C) of the inlet.
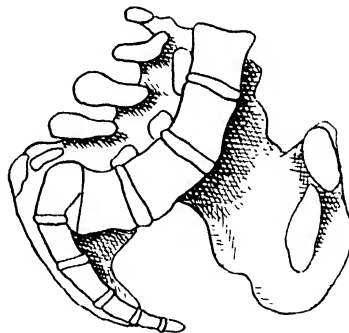
FIG. 154.   Spondylolisthetic pelvis.

The spondylolisthetic pelvis

The rare condition of spondylolisthesis appears to be familial, but a history of trauma may be obtained. It consists of a sliding forwards of the body of the fifth lumbar vertebra over the sacral promontory, and it is usually accompanied by rotation of the sacrum as in the kyphotic pelvis. The displaced lumbar vertebræ partially occlude the pelvic brim, and may make normal delivery difficult or impossible (Fig. 154). Nevertheless the

amount of forward dislocation of the lumbar vertebræ is often insufficient to cause any appreciable shortening of the true conjugate of the brim, and more than one normal labour may have occurred before the diagnosis is established.

The oblique or asymmetrical pelvis

If one leg is shorter than the other as a result of injury, poliomyelitis, or hip disease, the pelvis tilts towards the affected side, and there is a compensatory scoliosis of the spine. If the condition has arisen before puberty

Brim
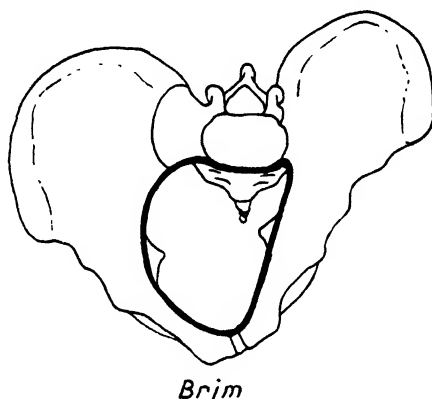
FIG. 155. Asymmetrical Nægele pelvis.

Brim
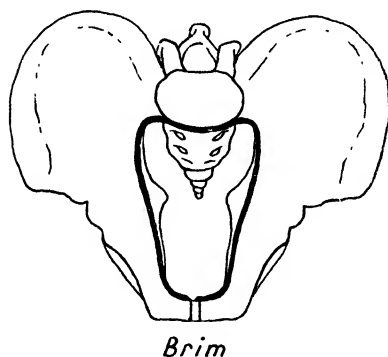
FIG. 156. Traversely contracted, Robert's pelvis.

considerable asymmetry of the pelvis may be produced by the unequal distribution of the body-weight. An asymmetrical pelvis may also be produced by malunion of fractures of the pelvic bones, and finally the rare

Nægele's oblique pelvis results from defective development of the lateral mass of one side of the sacrum.

In many asymmetrical pelves the contraction of one-half of the pelvis is compensated by enlargement of the other half, and the head may be accommodated without difficulty in the more roomy side of the pelvis. Disproportion or obstruction of labour may, however, occur, especially with the oblique pelvis of Nægele.

The transversely contracted pelvis of Robert

In this exceedingly rare pelvis there is a congenital absence of both lateral masses of the sacrum, with synostosis of the sacro-iliac joints (Fig. 156). The transverse diameters of the pelvis are markedly contracted, and Cæsarean section is usually necessary if pregnancy occurs.

CEPHALO-PELVIC DISPROPORTION

DISPROPORTION between the fœtal head and the maternal pelvis means either that the head is too large to go through the pelvis safely. The pelvis in most women is large enough to allow the fœtal head to go through with room to spare. The size of the fœtal head at term is partly determined by the size of the maternal pelvis (small women tend to have small babies), so that in the absence of pelvic deformity the majority of labours will proceed without mechanical difficulty or disproportion. However, there are exceptions to this rule, and the obstetrician must not only look out for abnormalities of the pelvis, but in addition must endeavour to exclude disproportion in every patient, even though the pelvis is thought to be normal.

Disproportion may occur at the pelvic brim or in the lower pelvic strait, or outlet, and the problems connected with these two types of disproportion are very different. It is easier to assess the possibility of disproportion at the brim, because the fœtal head can usually be used as a pelvimeter during the last month of pregnancy. Clinical examination and measurement of the pelvic diameters at the outlet must never be neglected, more especially as the fœtal head cannot be used as a pelvimeter. Disproportion at the outlet is rare. When the pelvic brim is large enough to allow the head to pass through it is uncommon to meet any difficulty at the outlet. Moreover the fœtal head has already undergone some moulding by the time it reaches the outlet and the antero-posterior diameter of the outlet is capable of slight enlargement due to backward rotation of the sacrum. If the pelvic brim is small and the pelvis is funnel-shaped disproportion may be most marked at the outlet.

The diagnosis of disproportion

Obstetric history. The possibility of disproportion should be suspected when there is a history of a previous long labour or difficult delivery, with perhaps a stillborn child, or a previous Cæsarean section for disproportion. A prolonged labour with forceps delivery is not invariably due to disproportion, and is in fact more often due to abnormal uterine action; similarly a previous Cæsarean section does not necessarily mean that disproportion was present. The birth-weights of previous children, if any, should always be noted, but this is not an infallible guide to the expected birth-weight or size of the fœtus in a subsequent delivery.

Examination of the pelvis. Some abnormalities may be discovered on pelvic examination, and it is always necessary to assess by vaginal examination the brim, the cavity and the outlet.

(a) *Assessment of the brim* is difficult, because as a rule the sacral promontory cannot be reached. If the sacral promontory can be felt the pelvis is small and further studies are indicated. The diagonal conjugate, which is the distance between the promontory and the lower margin of the symphysis, should be measured (Fig. 157). The antero-posterior diameter of
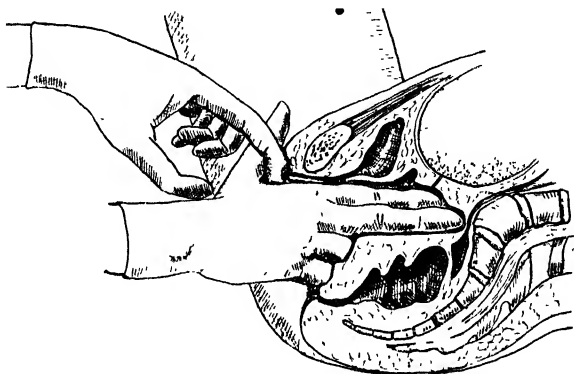
FIG. 157.   Measuring the diagonal conjugate.

the brim or true conjugate is normally 1·25 cm. ($\frac{1}{2}$ in.) less than the diagonal conjugate, but this is variable, and the diagonal conjugate should measure 12 cm. (4$\frac{3}{4}$ in.). The best way of assessing the brim relative to the fœtal head is to push the head into it, if it is not already engaged. If then the head will not engage, disproportion is suspected.

(b) *Assessment of the cavity.* The anterior surface of the sacrum should be felt from above downwards. In some cases the concavity is marked, and the lower part of the sacrum may project forwards considerably; in other cases the upper part of the sacrum may be straight or even slightly convex. The antero-posterior diameter of the cavity is the distance between the junction of the second and third sacral segments and the middle of the posterior surface of the symphysis, but it may be assessed clinically by measuring to the lower border of the symphysis as with the diagonal conjugate.

(c) *Assessment of the lower pelvic strait.* This distance between the ischial spines, normally 10 cm. (4 in.), is difficult to measure clinically but the spines should be found by sweeping a finger down the curve of the sacro-sciatic notch on each side, and with experience an impression may be formed as to whether the inter-ischial spinous diameter is normal or not. The antero-posterior diameter of the outlet is measured from the sacro-coccygeal joint

to the lower border of the symphysis, and the mobility of the coccyx should be noted. If the coccyx is fixed the antero-posterior diameter should be measured from the tip of the coccyx. It normally measures 13·1 cm. (5¼ in.). The available antero-posterior diameter is lessened if the subpubic arch is narrow, and an attempt should be made to assess the subpubic angle by placing two fingers under the arch. If the transverse diameter of the outlet is reduced the distance between the two ischial tuberosities is less than normal and four knuckles of the fist do not fit comfortably between them.

The fœtal head. The use of the fœtal head as a pelvimeter at, or after, the 36th week of pregnancy is of the greatest importance in the diagnosis of disproportion at the brim. It is an additional reason for attempting version in cases of breech presentation.

The head is said to be engaged in the pelvis when the widest transverse diameter has passed through the plane of the brim. Very little of the head can be felt on abdominal examination, and the examining fingers cannot be dipped below the presenting part. When the head is entirely above the brim, the fingers can easily be dipped below the head, which is said to be free, and can usually be moved a little from side to side. Sometimes the head is fixed, but not fully engaged. On the other hand a small head may be mobile while engaged in the pelvis.

If the head is found to be engaged in the pelvic brim during the last month of pregnancy, brim disproportion is of course, excluded. If the head is not engaged or is free above the brim an attempt should be made to cause it to engage. This may sometimes be achieved by direct pressure backwards on the head when the patient is lying flat, but this method may be unsuccessful. It is better for the patient to support herself on her elbows or on a back rest at an angle of 45 degrees, as this posture will tend to cause the head to engage in the brim. The head is now palpated immediately above the symphysis pubis. It may now be found that the head is engaged, but if not it should be ascertained whether the head overlaps either the posterior border or the anterior border of the symphysis. Such overlap may still be due to other factors such as poor flexion of the head, but disproportion should be suspected if the head is not engaged.

Instead of asking the patient to sit up she may be asked to stand, when the same observations can be made.

Disproportion can also be assessed during the last month of pregnancy by examination under an anæsthetic with the patient in the lithotomy position. Two fingers inserted into the vagina assess the descent of the fœtal head, when it is being pushed into the pelvic brim by the other hand *per abdomen* (Fig. 158). This is known as Munro Kerr's method, and though effective, it is seldom used now, as it has been largely superseded by X-ray diagnosis of disproportion. If the head cannot be made to engage, the

amount of overlap in front of either the posterior or anterior border of the symphysis can be estimated; overlap can be caused by deflexion of the head, and it is therefore necessary to define the position of the head and make sure it is not badly flexed when the degree of overlap is being assessed.

FIG. 158. Munro Kerr's method of estimating the relative sizes of the mother's pelvis and the child's head.

Radiological methods of diagnosis

Radiology is a valuable aid in the diagnosis of pelvic contraction and disproportion, but it must be remembered that excessive exposure to X-rays can harm the fœtus, and as few films as possible should be taken. Radiographs of the pelvis should not be taken in the early months of pregnancy, when the fœtus is most liable to be affected by X-rays; they are of more value in the last few weeks of pregnancy, when the fœtal head can be compared with the pelvis.

X-ray pelvimetry may give a more accurate picture of the shape and size of the pelvis than clinical examination, but must never be allowed to supplant clinical examination of the pelvis. Measurement of the fœtal head by X-rays should only be regarded as approximate, and in some cases the position or attitude of the fœtal head makes cephalometry quite inaccurate; for example it is out of the question if the head is in the fundus or in one or other iliac fossa.

Radiographs may sometimes be of value during the course of labour, but it must be recognized that the result of a trial of labour cannot be foretold by radiological examination, because it also depends upon the efficiency of the uterine action and the degree of moulding which the fœtal head can safely undergo. Radiology should never replace routine clinical examination, but should be used only to confirm, or refute, the clinical
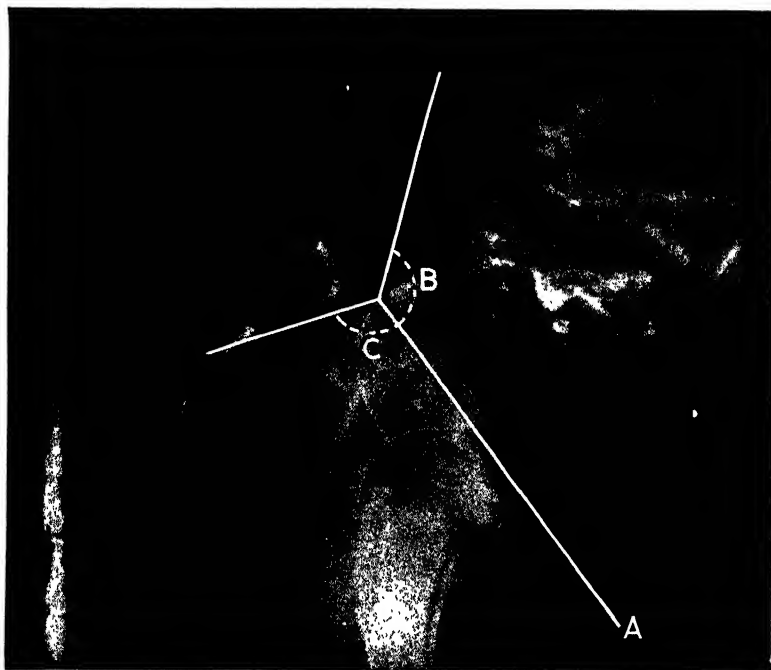
FIG. 159.   A lateral X-ray of the pelvis, the fœtus is in an occipito-posterior position (Chassar Moir).

A, plane of the inlet. B, angle of inclination of the pelvic brim. C, angle of inclination of the sacrum.

suspicion of abnormality. The exclusion of disproportion is sometimes of great value, reassuring both obstetrician and the patient that vaginal delivery is feasible, but even so routine pelvic radiological examination of normal primigravidæ is quite unnecessary.

Radiological examination may be requested:

1. When clinical examination of the pelvis at, or after, the 36th week suggests some abnormality in the shape or size of inlet, cavity or outlet.

2. If the patient has had a previous difficult forceps delivery, or a Cæsarean section for suspected disproportion.

. If the fœtal head is high in the last few weeks of pregnancy and does not engage in the pelvic brim, even when the patient sits or stands up. In this case it is usually sufficient to take a lateral erect film, and if the head is seen to be engaged further films are unnecessary.

If there is a persistent malpresentation, such as breech which cannot be turned, or a face or brow presentation. With a breech presenting the risk of irradiating the fœtal gonads must not be forgotten.

FIG. 160.   Antero-posterior view of pelvis.

Technique. Many different techniques have been described, but the following views of the pelvis are of most value:

1. *The lateral view* is taken with the patient standing erect, the fifth lumbar spine and symphysis being equidistant from the film, and the tube is centred just below the estimated mid-point of the true conjugate. In the film of a patient accurately placed the two femoral heads will be found to

overlap. This is the most useful single film of the pelvis and is the only one in use in some centres. It shows the length and curvature of the sacrum, and the curve of the birth canal, and it allows accurate measurement of the antero-posterior diameters of the brim, mid-cavity and outlet. From this film also the angle of inclination of the inlet plane to the lumbar spine and sacrum can be measured. It shows the level of the presenting part, and if the head presents, its degree of flexion or extension; the presenting diameter can be compared with the antero-posterior diameters of the pelvis, provided that the head is fixed in the mid-line (Fig. 165).
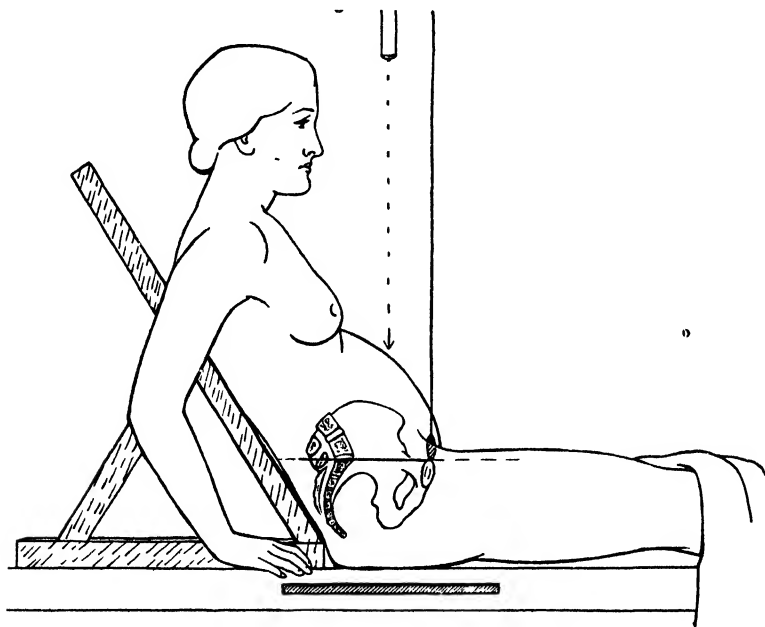
Fig. 161.   Radiolological pelvimetry. To show position of the patient, film, X-ray tube, and plumb-line.

2. *An antero-posterior view* is taken with the patient lying supine, and the tube is centred 7·5 cm. (3 in.) above the upper margin of the symphysis. This film shows the position and degree of flexion of the head, if it presents, and its relation to the pelvic brim; it also shows the amount of convergence or divergence of the side walls of the pelvis. It is of more value if a pair of stereoscopic films is taken, but in fact this view is useless for assessment of the size of the pelvis (Fig. 160).

3. *A supero-inferior view* is taken with the plane of the pelvic inlet as near as possible parallel with the film, on which the patient sits. The top of the symphysis should be level with the tip of the fifth lumbar spine, and the

tube is centred 6 cm. (2½ in.) behind the symphysis (Fig. 161). This film shows the shape of the pelvic inlet, and from it the diameters of the pelvic brim can be accurately measured, provided it was exactly parallel with the

FIG. 162.   Supero-inferior view of pelvic inlet. The generally contracted or small round pelvis.

FIG. 163.   Outlet view, showing normal sub-pubic arch.

film (Fig. 162). In the majority of cases the inter-ischial spinous diameter can also be measured, although it is on a plane much nearer to the film, and its position in relation to symphysis and sacrum can also be determined.

14*

Although this supero-inferior view is of considerable value, it is now usually omitted because of the dosage of X-rays needed to traverse the long axis of the uterus.

4. *A view of the outlet* is taken with the patient sitting on the table, with her body inclined well forwards, so that her abdomen rests between her separated thighs; the tube is centred over the sacrum, with a forward angulation of 10 degrees, so that the central exit ray is in the middle of the sub-pubic arch (Fig. 163). This film shows the shape of the subpubic arch and allows measurement of its angle, and of the inter-tuberous diameter. If the subpubic arch is narrow the head cannot emerge close to the symphysis, and from the film a point can be determined, some distance below the lower border of the symphysis, from which the available antero-posterior diameter of the outlet can be calculated, using a similar point on the lateral film.

Reconstruction charts can be drawn from the tracings of these films, showing the true size and shape of the pelvic inlet, mid-cavity and outlet, and these are of great value in assessing the prognosis in borderline cases of disproportion.
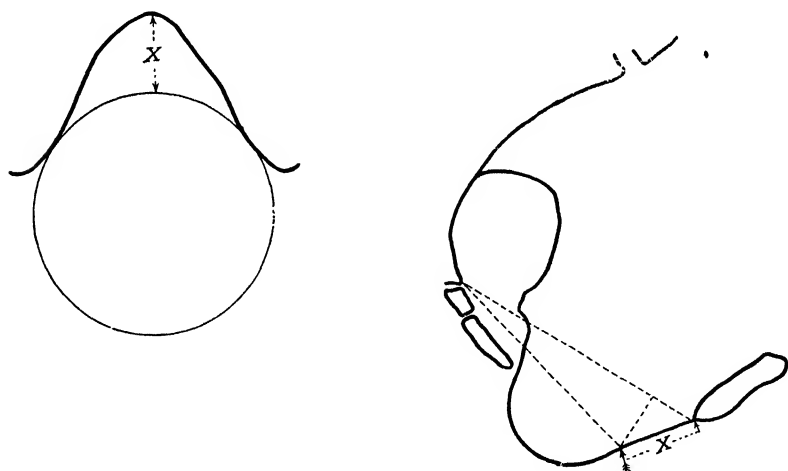
FIG. 164.   Reconstruction chart of outlet showing the available A.P. diameter.

A circle with a diameter of 9 cm. (3⅝ in.), representing the size of an average fœtal head at term is fitted into the sub-pubic arch: the distance between the nearest point on the circumference of this circle and the lower border of the symphysis pubis (x) is measured. The same distance (x) is marked on the lateral chart; the measurement to the end of the sacrum gives the available antero-posterior diameter.

Value of X-ray pelvimetry and cephalometry. Although knowledge may be gained by the more accurate radiological assessment of the pelvis and fœtal head, it must be appreciated that it is not possible by radiological

methods to forecast the outcome of labour. Neither the degree of moulding which the fœtal head may undergo, nor the possible increase in size of pelvic diameters in labour can be determined radiologically. Although the diameters of the pelvic brim are capable of little expansion, the antero-posterior diameter of the outlet can probably be stretched to some extent. Furthermore, the outcome of labour will depend to a very large extent on the force and efficiency of uterine action. An efficient uterus may overcome a moderate degree of disproportion, by causing flexion and moulding of the fœtal head whereas incoordinate uterine action may cause prolonged and difficult labour, even when disproportion is known to be absent.

Radiology is useful in excluding disproportion; many patients might otherwise be treated by Cæsarean section for suspected but unproved disproportion. Radiographs are also of value in the borderline group, in which some disproportion is present, but in which vaginal delivery should result with careful management following a trial of labour; finally in the comparatively rare cases of gross pelvic abnormality the necessity for elective Cæsarean section will be confirmed by X-rays. Nevertheless the dangers of radiology must not be forgotten, and X-rays should not be taken without very definite clinical reasons, and the fewer films taken the better.

Diagnosis of disproportion during labour

Although disproportion should be suspected if the head remains at or above the pelvic brim during the first stage of labour, it is not necessarily present. In multiparous patients, particularly, the head may remain high until the cervix is fully dilated, and then descend rapidly during the second stage of labour. Disproportion or malpresentation should also be suspected in cases of hypertonic uterine action. Marked caput formation with œdema of the cervix and over-riding of the parietal bones are diagnostic of disproportion at the brim during the first stage of labour. In some cases a large caput can be felt at the level of the ischial spines before the head has completely engaged in the pelvic brim. In addition there may be retention of urine and difficulty may be experienced in passing a catheter. X-rays are sometimes helpful during a trial of labour to determine whether the greatest transverse diameter of the head has passed through the plane of the brim, or whether there is sufficient moulding of the head to allow it to pass through (Fig. 165).

Disproportion at the outlet may cause delay in the second stage of labour, and as a rule the fœtal head will be found in the position of deep transverse arrest at the level of the ischial spines. In the rare cases of disproportion at the pelvic outlet the diagnosis may be made only when forceps have been applied after manual rotation of the head, and it is found that more than the usual amount of force has to be used to effect delivery.

Treatment of disproportion

There are several methods of treating a patient with disproportion, and it is therefore obvious that different views may be held in a particular case. The increased safety of the Cæsarean operation, due to chemotherapy,

FIG. 165.   Lateral view of the pelvis, showing moulding of the fœtal head during labour.

The arrows point, respectively, to the sacral promontory and to the lower border of the symphysis pubis.

blood-transfusion and the lower segment technique, has greatly increased its scope in the treatment of disproportion; it has entirely replaced the high forceps operation for obstruction at the brim, and few obstetricians now advocate or practice symphysiotomy. Craniotomy is never performed now on a living normal fœtus; and finally Cæsarean section may be safely accomplished in a patient when delivery with the forceps has failed, Nevertheless it must be recognized that the maternal mortality

of Cæsarean section is higher than that of vaginal delivery, and it does not guarantee survival of the child. It should not, therefore, be lightly undertaken in cases of suspected but unproved disproportion.

Trial of labour is the treatment of choice in patients with a minor or moderate degree of disproportion at the brim, particularly in a young primigravida with no complicating obstetric factors.

In this method of treatment labour is allowed to begin. The patient is carefully watched during labour in the hope that uterine contractions will cause sufficient moulding of the head to overcome a minor or moderate degree of disproportion; the biparietal diameter of the fœtal head may sometimes be reduced by as much as 1·25 cm. ($\frac{1}{2}$ in.) during labour. A trial of labour may terminate successfully in a spontaneous delivery or a low forceps delivery. If it fails it may be necessary to resort to Cæsarean section because of failure of labour to progress, or maternal or fœtal distress. Cæsarean section is safer for both mother and child than the difficult and dangerous high forceps operation. Trial of labour should only be undertaken in a hospital where adequate facilities for Cæsarean section are present.

The management of a trial of labour requires careful attention to detail and the progress of labour must be carefully watched. Records should be kept of the maternal pulse-rate and the fœtal heart-rate. The patient should be encouraged to expect a successful outcome, and should not be allowed to become aware that a trial of labour is proceeding, which may possibly end in Cæsarean section. The progress of the head through the brim is observed by abdominal palpation and vaginal examination. Vaginal examination must be performed when the membranes rupture, to exclude prolapse of the cord and to estimate the progress of dilatation of the cervix and descent of the head. Further vaginal examinations should be performed if it is thought that the head is not passing through the brim, to discover if signs of impending obstruction are present; marked caput formation, œdema of the cervix and over-riding of the parietal bones should be looked for. In cases of doubt it may be helpful to have a lateral X-ray of the pelvis taken during labour, if facilities are available.

It is not possible to give a set time to the duration of a trial of labour, as the force and frequency of the uterine contractions are so variable. Labour should be allowed to continue so long as progress is being made, provided there is no fœtal distress. The progress of labour is judged firstly by evidence of engagement and descent of the head on abdominal palpation, and secondly by continuing dilatation of the cervix and descent of the head on vaginal examination. Sometimes the head remains high for a considerable time during the early part of a trial labour, but descends through the brim without much difficulty when the membranes rupture and the cervix

TRAUMATIC LESIONS

RUPTURE OF THE UTERUS

RUPTURE of the uterus is a most serious condition. It generally occurs during labour but may also, though more rarely, occur during the later weeks of pregnancy.

CAUSES

During pregnancy the commonest cause of rupture of the uterus is a weak scar after Cæsarean section. In rare instances rupture of the uterus may occur after myomectomy or hysterotomy, or after perforation of the uterus with a curette.

Rupture of the uterus during pregnancy has also followed a direct blow on the abdomen, and perforating wounds may injure the uterus.

During labour rupture may be due to:

1. Obstructed labour. In these cases rupture may be spontaneous or, more likely, follow manipulations carried out for the relief of the obstruction.
2. Intra-uterine manipulations, such as internal version or manual removal of an adherent placenta.
3. Forcible dilatation of the cervix. Rarely a cervical tear in a normal delivery may extend up into the body of the uterus.
4. The injudicious use of pituitary extract or ergot.
5. A weak scar in the uterus after Cæsarean section, or in rare instances after myomectomy or hysterotomy, or after perforation of the uterus with a curette.
6. Degeneration of uterine muscle, which is most likely to occur in women who have had numerous pregnancies.

PATHOLOGY

Ruptures of the uterus are divided into (1) complete or intraperitoneal, and (2) incomplete or extraperitoneal, depending upon whether the peritoneal coat is torn through or not. A tear into the broad ligament is not complete unless the effused blood bursts through into the peritoneal cavity.

In obstructed labour rupture of the uterus generally takes place in the over-stretched and thinned lower segment of the uterus, and may be limited to it, but sometimes spreads upwards or downwards. With the head over the brim of the pelvis the posterior wall of the uterus usually

gives way, but with an oblique lie the transverse stretching tends to cause a lateral rupture. Although the over-stretched lower segment may give way as a result of the uterine contractions, the rupture more commonly results from operative measures undertaken to deliver the fœtus, such as forcible dilatation of the cervix, version, delivery with forceps, or craniotomy. When the rupture is complete the fœtus usually escapes into the peritoneal cavity, but if the presenting part is firmly fixed in the pelvis only part of the fœtus will escape.

The life of the mother is threatened by shock and intra-peritoneal bleeding. There is also a high risk of peritonitis because rupture occurs in cases of prolonged labour, or after repeated examinations or intra-uterine manipulations have been made. In cases of obstructed labour the fœtus is often dead before the rupture occurs, but in any case it will almost certainly perish if complete rupture occurs.

Rupture of a scar in the uterus usually occurs during labour, but may also occur in the later weeks of pregnancy. In this country a weak scar is now the commonest cause of rupture of the uterus; nearly all cases of rupture during pregnancy are due to this cause, and the majority of the cases occur during labour. Overdistension of the uterus, by twin pregnancy, for example, will increase the risk of rupture of a scar. Healing of a scar may be imperfect if gross sepsis occurs during the puerperium, of if the edges of the incision are inaccurately sutured. If the placenta is implanted over the scar the risk of rupture is increased; and also if section is repeated several times, when the incision of the latest operation is made through the scar tissue left by the earlier operations. During pregnancy a scar in the opper uterine segment is less secure than a scar in the lower segment. In labour also the lower segment scar is the safer, although occasionally rupture occurs. Until recently nearly all the cases of scar rupture followed classical Cæsarean section. Although the incidence of rupture has been reduced since the introduction of the lower segment operation, rupture of the lower segment now appears to be relatively more common, but this is only because classical section is now so rarely performed.

A Cæsarean scar in the uterus may stretch gradually, so that the wall in the region of the scar is only represented by attenuated and avascular fibrous tissue. For this reason, when the weak area finally gives way there is sometimes relatively little intra-peritoneal bleeding. The membranes bulge through the rent, and will eventually give way, when the fœtus or placenta may pass through it.

SYMPTOMS AND SIGNS

Rupture due to direct injury to the abdomen. In the rare cases of rupture due to direct injury to the abdomen, severe shock and abdominal pain,

together with the history of the accident, will suggest the possibility of visceral injury. Precise diagnosis may be impossible without laparotomy, but in case of doubt this would be well justified.

Rupture through a uterine scar. In cases of rupture through a uterine scar during pregnancy the history of the previous operation will be available. Occasionally the attenuated scar of a classical Cæsarean section may be palpable through a thin abdominal wall as a sulcus in the uterus, which bulges with uterine contractions and is tender. Rupture during pregnancy may be so gradual, and attended by so little bleeding, that the symptoms may at first be very slight, and the description 'silent rupture' has been applied to these cases. There is abdominal pain, often central and related to the region of the scar, but at first there may be little change in the general condition of the patient. If the rupture becomes complete and part of the uterine contents are extruded into the peritoneal cavity more severe pain and shock occur. The diagnosis is often difficult, and it may be necessary to observe the case for a short time before a conclusion is reached. Tenderness in the neighbourhood of the scar is on the whole the most useful sign; only in rare instances will free fluid in the peritoneal cavity or bulging of part of the fœtus through the rent be evident. Pain due to rupture in pregnancy may be misinterpreted as pain due to the onset of labour.

Rupture of a scar occurs more commonly during labour, when the scar gives way more suddenly than during pregnancy, so that the symptoms are more dramatic, with severe pain and shock. Unless the contents of the uterus pass into the peritoneal cavity uterine contractions may continue. The possibility of rupture of the scar should always be considered if a patient who has had a Cæsarean section suddenly complains of severe pain during labour which is not synchronous with the uterine contractions. The accident does not usually occur after a long and difficult labour, and for that reason the patient's general condition is better, and the risk of infection less, than in cases of rupture due to obstructed labour.

Spontaneous rupture in obstructed labour. The preceding labour will have been prolonged, or there will have been violent uterine action almost without intermission between the pains, so that the patient may be exhausted before the rupture occurs. There may be obvious signs of disproportion, or of a malpresentation such as a transverse lie, although these signs may have been overlooked before the accident. At the moment of rupture the patient cries out and complains of a sharp pain in the lower abdomen. Soon after the rupture she presents symptoms of shock, her face becomes pale and drawn, and her forehead is covered with a cold sweat. The pulse becomes thready in character, and its rate becomes rapid. The blood-pressure falls. The signs of shock may not always appear at once; after an incomplete tear the symptoms are sometimes slight, and when the child is partly expelled through a complete rent hæmorrhage is controlled by

retraction of the uterus onto that part of the child which is gripped by the uterine wall.

Vaginal hæmorrhage is usually slight or absent. On abdominal examination there is no constant sign. A bulge may be felt in the uterine wall, or if the fœtus has completely escaped into the peritoneal cavity it may be felt beside the small retracted uterus. If the child is completely extruded uterine contractions may cease, but in other cases often continue. On vaginal examination no presenting part may be felt, unless the head is impacted in the pelvis.

Rupture after intra-uterine manipulations. In these cases the patient is usually anæsthetized when the manipulation is taking place, so that the first evidence that anything is amiss may be a sudden deterioration in her general condition, either at the time, or later on as the effect of the anæsthetic passes off. In some cases the signs may not appear until a few hours after delivery.

In other instances the operator may discover the injury while his hand is still in the uterus. After any difficult manipulation it is wise to examine the uterus carefully to exclude any injury.

Extensive cervical lacerations. In some respects these injuries resemble the previous group, as they are usually produced with the forceps at a difficult delivery, or if the cervix is not fully dilated, but they seldom extend far enough to open the peritoneal cavity. Brisk external hæmorrhage may occur (see p. 447), or a large hæmatoma may form in the broad ligament (see p. 446). Vaginal bleeding in the third stage of labour with an empty and firmly retracted uterus should suggest the possibility of this type of injury, which can be confirmed by digital examination.

Rupture due to ecbolic drugs. Rupture of the uterus has followed the administration of pituitary extract or ergot before the delivery of the child, particularly when there was some obstruction which prevented rapid delivery. There should be less danger when syntocinon or oxytocin is used as a dilute intravenous drip and the uterine contractions can be observed and controlled. It is wise to begin with a concentration of not more than one or two units per litre. Several cases of uterine rupture have followed the use of buccal oxytocin. Ergometrine intramuscularly, or by intravenous injection, during the crowning of the head or the delivery of the anterior shoulder is quite safe.

PROGNOSIS

The maternal mortality resulting from rupture of the uterus in cases of obstructed labour is very high, about 50 per cent, and is higher in the complete than in the incomplete variety. This high mortality is due to the fact that this accident usually occurs in cases of prolonged labour with

much manipulation, often complicated by sepsis, and with inefficient obstetric aid.

The mortality following rupture of a Cæsarean scar is much less, about 2 or 3 per cent, as the accident does not usually follow prolonged labour or difficult manipulations, and the patient is usually confined in hospital, where the rupture is more quickly detected and immediately treated.

The prognosis for the child is bad, the fœtal mortality in the cases following obstructed labour being about 85 per cent, but less (45 per cent) in the cases of scar rupture.

Better obstetric care, earlier diagnosis of rupture, blood-transfusion, and the introduction of the antibiotics have reduced the maternal mortality. Dangerous manipulations are now less often performed and cases of obstructed labour are less often seen, but these difficulties are avoided by Cæsarean section, so that the increased risk of scar rupture must be set against this.

TREATMENT

Prophylactic treatment. Rupture of the uterus will be prevented by improvement in the standard of practical obstetrics, and in particular in the proper management of complications. Thus, disproportion must be recognized early, and labour must not be allowed to continue to the stage of obstruction. An oblique lie must be corrected at an early stage, but if the shoulder has become impacted, the liquor amnii has drained away, and the uterus become tightly retracted, version should not be attempted; either decapitation or Cæsarean section is the correct treatment. The cervix must not be forcibly dilated; and manual removal of the placenta must be carefully performed, with an external hand guarding and indicating the level of the fundus.

A patient who has had a Cæsarean section or extensive myomectomy should be admitted to hospital for any subsequent delivery, where all facilities are available. However, the fact that a patient has already had one Cæsarean section does not mean that all subsequent pregnancies must be terminated in this manner, provided that the first operation was performed for conditions other than disproportion. If she had a classical operation, and it is known that uterine infection followed the operation, elective section may be advisable, as it would be in the case of a woman who has already had two or more Cæsarean operations.

Treatment after rupture has occurred. Before carrying out any major abdominal operation the condition of the patient should be improved by giving morphia, by blood transfusion and, if necessary, by other intravenous fluid.

Cases in which the whole or part of the fœtus has escaped into the peritoneal cavity. These cases must always be dealt with by abdominal section.

Cases in which the tear is discovered after the birth of the child. If the placenta is in the peritoneal cavity, it is inadvisable to attempt to drag it through the tear by traction on the cord, because this will enlarge the rent and increase the hæmorrhage. To deliver the placenta, the abdomen must be opened, the placenta removed and the tear sutured if in a favourable position; otherwise hysterectomy should be performed.

Cases in which the tear is confined to the broad ligament will not be diagnosed till after delivery. The diagnosis as to whether the tear involves the broad ligament only will be determined by passing the finger into the rent. The hæmorrhage in these cases can usually be arrested by packing the cavity in the broad ligament.

Tears opening the posterior fornix, if complicated by prolapse of bowel, must be sutured and drained or the bowel replaced and kept back by a gauze plug in the pouch of Douglas. These accidents are unlikely under modern conditions and if they occur are probably best treated by laparotomy. Where an efficient theatre is not available the methods previously described may be justified.

Treatment of the ruptured uterus at laparotomy. Many cases are best treated by hysterectomy, as efficient suturing may be difficult and almost impossible if there is bruising or raggedness of the tissues involved. In the few cases with little bruising and an accessible tear, the rent should be excised and sutured. In cases of scar rupture it is often possible to excise the edges of the rent and resuture the uterus. Interrupted sutures are passed through the whole thickness of the uterine muscle and tied, and a finer continuous catgut suture is used to approximate the peritoneal edges. If the bladder is involved in the tear, its wall must be sutured in two layers and an in-dwelling catheter inserted.

ACUTE INVERSION OF THE UTERUS

Acute inversion of the uterus occurs only during labour. In this condition the body of the uterus becomes partially or completely turned inside out. The condition is an important cause of shock in the third stage of labour. Fortunately it is rare and its frequency depends chiefly on the care with which the third stage of labour is conducted. Three stages of inversion are described:

1. When the fundus bulges into the uterine cavity but does not protrude through the cervix.
2. When the fundus protrudes through the cervix.
3. When the inverted body passes completely through the os.

In the latter two stages the fundus may prolapse through the vulva and lie outside the body. Inversion may take place either before or after separation of the placenta.
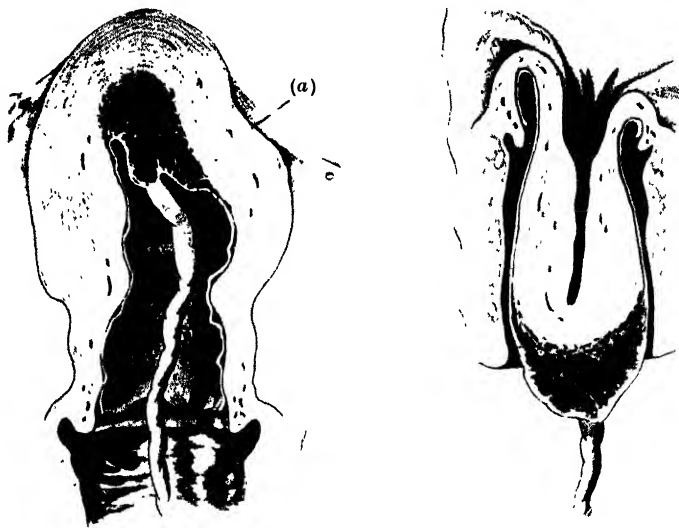
FIGS. 166 and 167.   Inversion of the uterus.

FIG. 166.   Fundal attachment of the placenta with a furrow on the anterior wall at the point (a) where the inversion is starting.

FIG. 167.   The inversion almost complete with the cup-shaped depression in place of the rounded fundus.

CAUSE

The commonest and most important cause is mismanagement of the third stage by the attendant pressing on the fundus, or pulling on the umbilical cord when the uterus is not contracting. The risk of inversion is increased if the placenta is attached to the uterine fundus. For the production of inversion of the uterus the uterine wall must be relaxed. It is possible that on very rare occasions the inversion may be spontaneous, if relaxation of the part of the uterine wall to which the placenta is attached permits this part to be carried down by a contraction of the rest of the uterus. The inversion may rarely be started by a short cord being dragged upon during an instrumental delivery in an interval between contractions.

SYMPTOMS AND SIGNS

The chief symptoms are shock, hæmorrhage, and the appearance of a swelling at the vulva. As a rule the shock is severe, and is greater than the

loss of blood warrants; the amount of bleeding will vary according to whether the placenta is separated or not, and a mass will be present in the vagina or outside the vulva. Pain is variable. Unexplained shock during the third stage of labour should always suggest that inversion of the uterus may have occurred. In most patients there is extreme shock, and death may occur very rapidly; very rarely, the symptoms may be so slight that the patient does not seek medical advice till the uterus has involuted, and the condition of chronic inversion is present. The diagnosis is made by the body of the uterus being absent from its usual position and a rounded mass being felt protruding through the cervix.

PROGNOSIS

Acute inversion has a mortality of over 40 per cent. Shock is the chief cause of the high death-rate, but a free and persistent loss of blood is also a factor in patients in whom the placenta has separated.

TREATMENT

The patient's life is threatened by shock and by bleeding, and both of these will continue until the uterus is replaced, hence it is desirable that the uterus should be replaced at once. The fundus of an inverted uterus soon becomes œdematous, and the œdema causes the fundus to become larger, making replacement more difficult; this is an additional reason for immediate replacement. The mortality is higher if replacement of the uterus is delayed while treatment for shock is being carried out. As soon as the diagnosis is made the patient should be given morphia 16 mg. (gr. $\frac{1}{4}$) and anæsthetized. After cleansing the vulva, vagina and inverted uterus, the placenta, if attached to the uterus, is stripped off. The uterus is then grasped in the hand and squeezed back into its proper position, the part which became inverted last being replaced first, and the fundus last of all; throughout the manipulation counter pressure is maintained upon the abdomen with the other hand.

If the condition is immediately recognized as it occurs and an anæsthetist is quickly available the foregoing method of treating the complication is probably the best. An alternative method of replacement is by intravaginal fluid pressure. Sterile water is run into the vagina from a douche can suspended above the patient. By closing the entrance of the vagina with the hand the intravaginal pressure is raised sufficiently to replace the uterus.

When the replacement is completed, further hæmorrhage should be prevented by the intravenous injection of pitocin and ergometrine. These drugs also improve the muscle tone and, therefore, tend to prevent a recurrence of the inversion. Recurrence may occur if the replacement is incomplete. The patient should also be treated for shock immediately the uterus has been replaced.

Should inversion be discovered some days after labour, an anæsthetic should be given, and an attempt made at reposition which will generally be successful. Should it fail, it is necessary to wait till involution is complete, when continuous pressure may be made on the fundus with Aveling's repositor, which is usually successful in reducing the inversion.

The treatment of chronic inversion of the uterus will be found in the Ten Teachers' *Diseases of Women*.
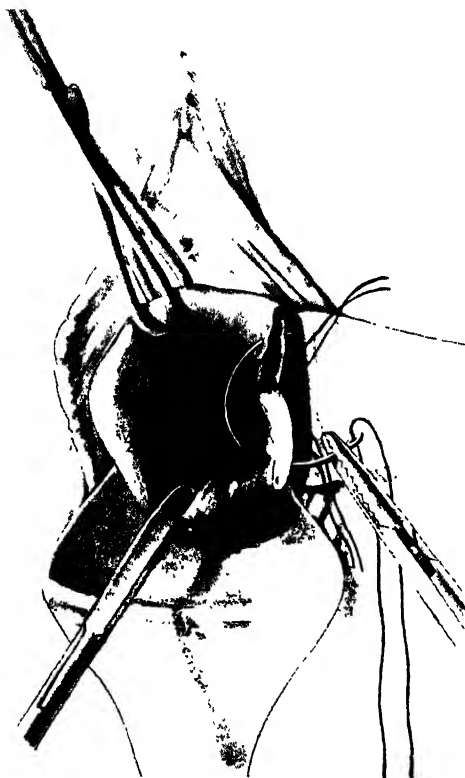
FIG. 168.   The repair of a tear of the cervix by interrupted catgut sutures. The cervix is depicted outside for the sake of clarity.

LACERATIONS OF THE GENITAL CANAL
Lacerations of the cervix

Lacerations of the cervix occur frequently but are often overlooked as they rarely give rise to immediate symptoms.

Extensive lacerations of the cervix may occur in precipitate labour, in a cervix in which there is scarring, when the forceps has been applied and

strong traction exerted with the cervix incompletely dilated, or in rapid delivery of the after-coming head in breech delivery with incomplete dilatation of the cervix.

When the cervix is deeply lacerated there may be continuous hæmorrhage during or after the third stage of labour, although the body of the uterus may be well retracted, and the bleeding will continue until the laceration is sutured. To do this the patient is anæsthetized and the anterior and posterior lips of the cervix seized with sponge forceps and drawn well down. Interrupted catgut sutures are inserted, passing through the thickness of the cervix. After the sutures are tied the hæmorrhage ceases. If the surroundings are not suitable for suturing the cervix the hæmorrhage may be temporarily controlled with sponge forceps which are left in place until the patient is removed to hospital.

Lacerations of the perineum and vagina

A first degree tear involves the anterior part of the perineum and the posterior wall of the vagina, but the tear may be overlooked if the labia are not separated and the vaginal walls examined.

A second degree tear involves the perineum up to the external sphincter with a corresponding tear in the vagina.

A third degree (complete) tear is of greater extent and includes the anal sphincter, and usually also extends for an inch or more up the anal canal.

It is important to realize that an extensive tear may occur in the vagina without a tear in the perineum and in consequence the vaginal walls should always be carefully inspected after delivery, in order that these vaginal tears may be sutured immediately.

Treatment of first and second degree tears. It is important to suture all perineal lacerations immediately to prevent any infection of the raw surface. Deep lacerations involving the perineal muscles lead to weakness of the pelvic floor, which may be followed later by vaginal or uterine prolapse.

The vaginal mucosa is sutured either with a continuous running fine catgut stitch (2/0 or 3/0 plain catgut is suitable) or with interrupted sutures starting at the apex of the tear and working down to the introitus. The perineal muscles are then approximated with interrupted catgut stitches and when this is done the skin edges come almost together. The skin edges are sewn together either with fine catgut stitches which do not have to be removed or with unabsorbable sutures which are taken out after 5 days. The repair should be done carefully and accurately. The patient will have a general, pudendal or local anæsthetic. Local anæsthesia, e.g. 1 per cent lignocaine is suitable for first and second degree tears but general anæsthesia is advisable for complete perineal tears. Extensive lacerations are

best repaired in hospital. Except where a hospital is not available a complete perineal tear should not be repaired in the patient's home.

FIG. 169.   Second degree perineal tear.

Treatment of a complete tear. The operation should be done by an experienced obstetric surgeon in a properly equipped theatre with a good light and with the help of an anæsthetist, assistant and theatre sister. If carefully sutured the tissues heal very well when the operation is done soon after delivery, but, if they fail to heal the patient will have to undergo a much more difficult operation later, or will suffer from rectal incontinence.

The anal mucosa is first sewn with interrupted 2/0 or 3/0 plan catgut sutures on a half circle 30 mm. atraumatic intestinal needle. The knots may be tied inside the bowel lumen, or having passed through the muscular coats only the knots are tied on the outer side so as to invert the torn edges of the rectum towards the lumen of the bowel. The superficial and deep external sphincter muscles are united with separate sutures. The vaginal mucosa is sewn up from the apex of the tear to the introitus. The levatores ani and tissues of the perineal body are united with interrupted catgut sutures to avoid leaving any dead space, and finally the skin edges are approximated by interrupted catgut stitches. (Fig. 170).

After treatment of perineal tear. The perineal surface is swabbed with an antiseptic solution and should be kept as dry as possible. No specific
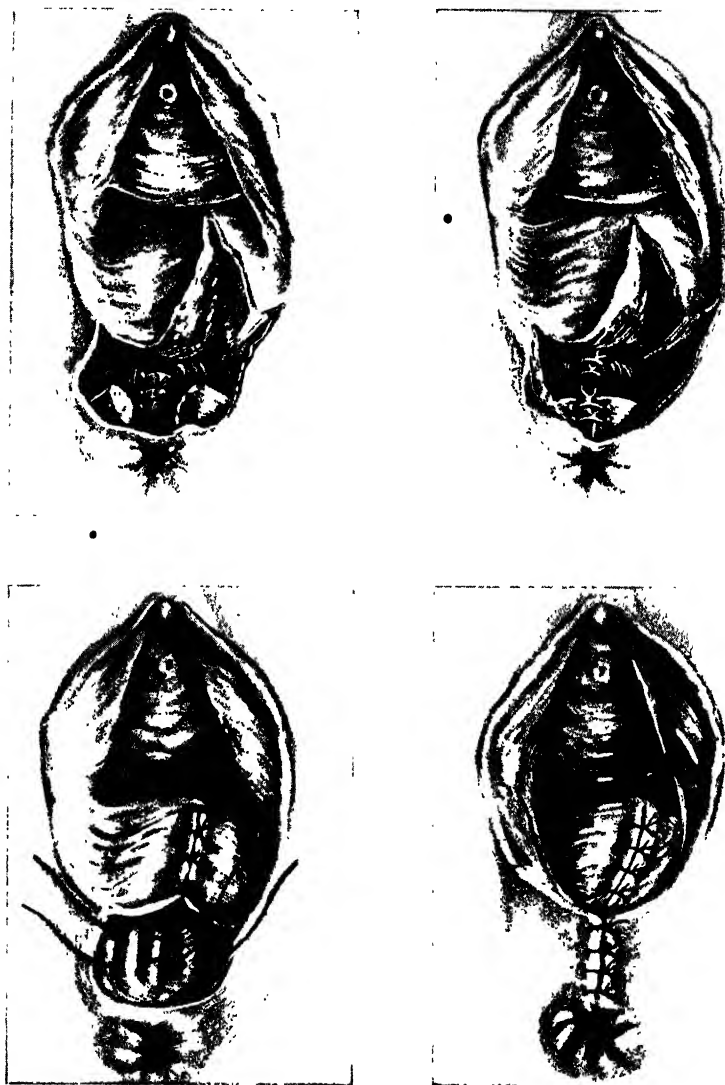
FIG. 170. Repair of complete perineal tear.

treatment is required for third degree tears provided the repair has been carried out properly. If the patient suffers from inability to pass flatus a

soft rubber catheter should be carefully inserted into the canal. If she has difficulty with micturition an indwelling catheter is inserted for 3 or 4 days.

FISTULÆ

Fistulæ may occur as the result of pressure by the presenting part in a case of prolonged labour, or by direct trauma during operative procedures. The pressure is generally caused by the head, as the breech is not sufficiently hard to cause damage.

If the head is delayed above the brim in obstructed labour, prolonged pressure on the uterine wall against the symphysis pubis or the promontory of the sacrum may cause a local anæmia and subsequent necrosis may cause a vesico-uterine fistula. It is possible for the head to be arrested in the pelvic

FIG. 171.   Diagram to show positions of fistulæ.
A, Vesico-cervical fistula.   B, Vesico-vaginal fistula.
C, Urethro-vaginal fistula.   D, Recto-vaginal fistula.
C is a very rare form of fistula and may not result in incontinence like A and B, but only in urine dribbling through the vagina during micturition.

cavity by some moderate degree of general contraction of the pelvis, or a large head, and for the pressure to cause sloughing of the anterior vaginal wall and the base of the bladder, with the formation of a vesico-vaginal fistula.

The only common cause of a recto-vaginal fistula is a complete tear of the perineum extending into the recto-vaginal septum, followed by healing of the superficial and external part only.

Depending on the position of the fistula the patient passes urine, or flatus and fæces into the vagina. If due to a laceration the symptoms are manifest soon after delivery but, if due to necrosis following prolonged pressure, the symptoms do not usually appear till the 8th to the 10th day. On examination it is found that there is a hole leading into the bladder or rectum. Generally the destruction of tissue is greatest on the vaginal surface, and it sometimes happens that when this wound granulates the fistula heals. Unfortunately this is not always the case, and it will then be necessary to perform some plastic operation at a later date. Attempts should not be made to close these fistulæ till at least 4 months after the birth of the child when the tissues will have had time to recover from the effects of bruising and superadded infection and will therefore heal better if an operation is performed to close the defect.

HÆMATOMA OF THE VAGINA AND VULVA

Although it is rare this is a serious complication of pregnancy and labour, and is sometimes due to the rupture of varicose veins during the second stage of labour. It may be due to injury during delivery by the forceps. The patient complains of increasing pain in the neighbourhood of the lesion. The signs following rupture of the vein may only appear several hours after the child is born, as the escape of blood is prevented, for the time being, by the counter-pressure of the head.

The hæmatoma presents as a tender, œdematous swelling, purple in colour which spreads downwards and occupies one or other side of the vulva. Less frequently, the effused blood may track upwards, in which case the swelling will be found by the side of the vagina.

The predominant symptom is pain and in some patients shock may be a feature.

As a rule the blood is eventually absorbed, though occasionally it may become infected with resulting abscess-formation.

Treatment. If the hæmatoma is noticed before the birth of the child, delivery should be effected as quickly as is consistent with the safety of the mother and child. If the vein has ruptured externally, it will be necessary to stop the hæmorrhage by ligature.

If the tension of the swelling is great it should be incised, the clot turned out, and the torn vein, if it is seen, should be ligatured. Firm pressure must then be made by a dressing and bandage.

If the hæmatoma suppurates, the swelling must be incised and efficiently drained.

BROAD LIGAMENT HÆMATOMA

In rare cases the hæmatoma is partly below and partly above the levatores ani and, therefore, may spread into the base of the broad ligament, between the uterus and the bladder or by the side of the rectum. The cause of the effusion of blood is most often a pressure necrosis of the wall of a vein which gives way either before, during or after labour. It may be associated with an extra-peritoneal rupture of the uterus. Most frequently the bleeding occurs immediately after labour, so that the hæmatoma is discovered a few hours or days later, pain and deterioration of the patient's general condition being presenting symptoms. If the blood extravasation extends above the levatores ani muscles it can be felt only on bimanual examination. It may be large enough to be palpable on abdominal examination, and the uterus is then displaced upwards and to one side.

A broad ligament hæmatoma usually undergoes gradual absorption, more or less time being taken during the process, according to the amount of effused blood. Occasionally the blood-clot becomes infected and suppurates, especially if it is associated with a small external wound, but this complication is not frequent. Nearly all the fatal cases have been the result of septicæmia following infection of the hæmatoma in criminal abortion.

Treatment. The patient should be treated conservatively. Blood transfusion is usually indicated. Active intervention by incising should be reserved for those patients in whom infection occurs, and then an abscess should be opened and drained where it points.

MATERNAL NERVE INJURIES

Foot-drop, due to paralysis of the dorsiflexor muscles of the leg, may follow delivery.

In a few cases this may be due to pressure on the lateral popliteal nerve near the neck of the fibula by a leg support used to hold the patient in the lithotomy position.

In the majority of cases it is a different type of injury and is due to pressure on the fourth and fifth lumbar nerve roots. Opinions differ about the explanation of the lesion. It could be explained by a sudden prolapse of an intervertebral disk, which may occur during labour, or by pressure on the lumbo-sacral cord near the brim of the pelvis.

The lesion is usually unilateral, and it often follows difficult labour, especially forceps delivery. Apart from the foot-drop there is an area of anæsthesia on the dorsum of the foot and the lateral aspect of the ankle.

The prognosis is good although recovery may take several months. During that time a toe-spring is attached to the shoe to lift the foot during walking, and regular physiotherapy is given.

ANTEPARTUM HÆMORRHAGE

THE term antepartum hæmorrhage is applied to bleeding from the vagina occurring at any time after the 28th week of pregnancy and before the birth of the child.

As defined above, antepartum hæmorrhage may be divided into three classes:

1. Hæmorrhage due to the partial separation of a placenta normally situated on the upper segment of the uterus. This is called *accidental hæmorrhage*.

In these cases labour may progress without further bleeding.

2. Hæmorrhage due to the partial separation of a placenta abnormally situated on the lower uterine segment. This is termed *placenta prævia*.

In this class of case the placenta is so situated that hæmorrhage is inevitable when the lower segment becomes dilated in labour. The hæmorrhage here is the reverse of accidental, it is unavoidable. The term accidental thus has no connexion with the same word used to denote trauma, although trauma may cause hæmorrhage.

3. Hæmorrhage due to a lesion of the cervix or vagina such as an erosion, a polyp or a carcinoma. This may be called *incidental hæmorrhage*.

ACCIDENTAL HÆMORRHAGE

VARIETIES

1. Revealed. 2. Concealed.

Owing to the separation of a portion of the placenta from its uterine attachment, part of the wall of the intervillous space is removed and maternal blood escapes from the opened sinuses. This blood may track down between the membranes and the wall of the uterus and so escape at the cervix (*revealed accidental hæmorrhage*), or may remain inside the uterine cavity (*concealed accidental hæmorrhage*). Most often the hæmorrhage is partly concealed and partly revealed: this is *mixed concealed and revealed hæmorrhage*. In nearly every case of 'concealed' hæmorrhage there is a little external bleeding at some time.

CAUSE

In many cases no cause can be discovered. About 25 per cent of the cases are associated with pre-eclampsia, essential hypertension or (rarely)

chronic nephritis. It is not certain that the hypertension or albuminuria is the cause of the hæmorrhage; in a few cases albuminuria follows and does not precede the hæmorrhage.

It has been claimed that accidental antepartum hæmorrhage is caused by folic acid deficiency. The disease is more common with advanced parity and in lower income groups. It is stated that folic acid deficiency can be
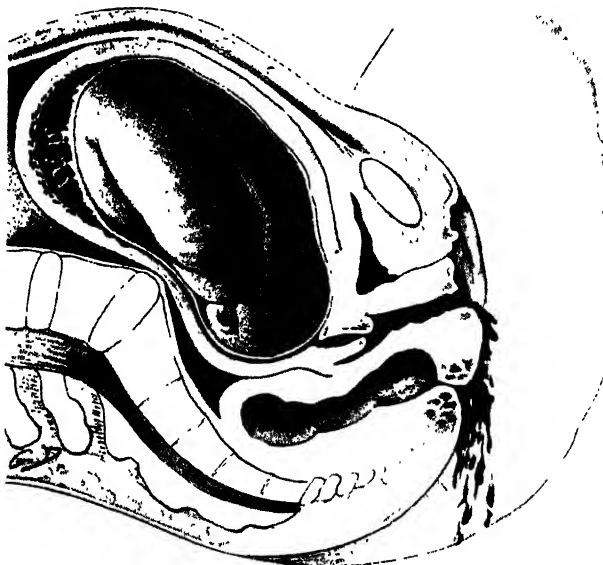
FIG. 172. Revealed accidental hæmorrhage.

recognized if the urinary excretion of foraminoglutamic acid (FIGLU) is increased after administration of histidine. Folic acid is required for the complete metabolism of histidine, which is excreted as FIGLU if there is a deficiency of folic acid. On the basis of this test there is said to be folic acid deficiency in some cases of accidental hæmorrhage. There is also said to be an association with cases of megaloblastic anæmia, which is due to folic acid deficiency. However, accidental hæmorrhage is not especially common in Nigeria, where megaloblastic anæmia is common.

A few cases of placental separation are due to trauma during external version. The bleeding in cases of accidental hæmorrhage may be of any degree from a small retroplacental hæmatoma, which may not affect the fœtus and which may only be discovered after the placenta is delivered, to a large collection of blood which distends the uterus and kills the fœtus by separating the placenta.

In severe cases blood is extravasated into the substance of the uterine wall and may be seen under the peritoneal surface (Couvelaire uterus).

It is usually stated that such hæmorrhage interferes with uterine contraction, and that it explains the continuing hæmorrhage which occurs in some of these cases, even after delivery of the fœtus and placenta. In fact this is improbable as the uterus is tense from spasm, rather than relaxed, before delivery. In concealed cases the whole uterus may be tense and tender, but in revealed or less severe cases there is more localized tenderness over the site of hæmorrhage. If a postpartum hæmorrhage occurs it may be due to hypofibrinogenæmia and failure of blood clotting rather than to atony of the uterus.

Hypofibrinogenæmia may occur because thromboplastin is forced into the maternal circulation, defibrinating the blood. Severe antepartum or postpartum blood loss may then occur because the blood does not coagulate.

There is some evidence to show that there is a utero-renal reflex, and that severe accidental hæmorrhage of the concealed type causes spasm of the renal arterioles. This may be sufficiently widespread and prolonged to cause bilateral renal cortical necrosis, which results in fatal anuria.

SYMPTOMS AND SIGNS

Revealed accidental hæmorrhage. With or without any obvious exciting cause the patient notices blood coming from the vagina. There may be slight abdominal discomfort and tenderness over the placental site.

The initial diagnosis is between accidental hæmorrhage and placenta prævia. Tenderness over the placental site, engagement of the fœtal head (in late pregnancy), and fœtal death or fœtal distress suggest that the symptoms are due to accidental hæmorrhage. However, in many slight cases the fœtus is not adversely affected, and in multiparæ the fœtal head may not engage until the onset of labour, even in normal cases. If the head is not engaged the placenta may be localized by radiological examination (see p. 462).

It is dangerous to attempt to exclude the presence of a placenta prævia by vaginal examination and the passage of a finger through the cervix. If the placenta should prove to be low-lying such an examination may cause very severe bleeding, and even if the placenta is not within reach there is the risk of starting labour. In exceptional cases in which the diagnosis is in real doubt and the degree of bleeding is such that investigation cannot be delayed, vaginal examination must be made in the operating theatre, with the patient anæsthetized and all preparations made for Cæsarean section, which could then be performed immediately if a placenta prævia was found.

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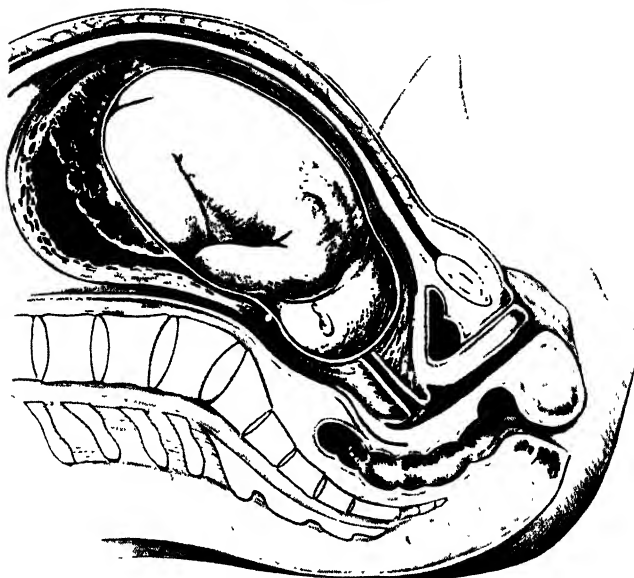
FIG. 173.   Concealed accidental hæmorrhage.
A collection of blood can be seen between the placenta and uterus and below
between the chorion and uterus, but blood has not reached the external os.

FIG. 174.   Concealed accidental hæmorrhage at end of second stage.
The placenta and a part of the membranes are separated from the uterine wall by a
mass of blood-clot.

On vaginal examination, friable smooth blood-clot may fill the vagina and cervix, but the placenta cannot be felt. The amount of blood lost varies from a slight show, which the patient may compare with a menstrual period, to a violent flooding.

Concealed accidental hæmorrhage. The symptoms and signs naturally vary with the severity of the case. In the extreme cases, the gravity of the patient's condition may be out of all proportion to the amount of blood effused into the uterus. Shock is due not only to the hæmorrhage but also to the painful uterine distension. In spite of severe shock with a low blood pressure the pulse rate may not be raised, at least for a time, and this may be misleading.

The over-distension of the uterus gives rise to severe and constant abdominal pain. The uterus may be larger than would be expected for the period of gestation reached and more globular in outline. It has a hard wooden consistence and is extremely tender. Contraction or relaxation cannot be detected, the fœtal outlines cannot be made out, and the fœtal heart cannot be heard. Vaginal examination is not usually indicated, but revealed hæmorrhage and dilatation of the cervix will occur with the onset of labour.

Should the loss of blood be smaller, the symptoms are correspondingly less severe. The patient complains of a sudden attack of abdominal pain and at the same time feels faint and suffers from nausea. She looks ill, her mucous membranes are pale, and the pulse-rate is raised. An abnormality may not be discovered on abdominal examination, except that palpation of the uterus elicits tenderness, usually localized to the placental site, and if a sufficient area of placenta has been detached, the fœtal heart is often inaudible. A correct diagnosis is important as such a patient is likely to have a recurrent and more serious hæmorrhage. Albumin may be present in the urine.

Mixed concealed and revealed accidental hæmorrhage. The symptoms and signs may be those of concealed hæmorrhage with some external loss, and generally some dilatation of the cervix; or there may be external hæmorrhage with little or no evidence of distension of the uterus by retained blood, although after delivery, a quantity of dark blood found behind the placenta and membranes will show that concealed bleeding has occurred.

The severity of a case with external hæmorrhage must never be judged solely by the amount of blood lost *per vaginam* but by the general condition of the patient. A trifling external loss may be accompanied by serious internal hæmorrhage.

Revealed accidental hæmorrhage. Revealed accidental hæmorrhage simulates placenta prævia, and in many cases an immediate distinction is not possible. Placenta prævia is suggested by a history of recurrent attacks of bleeding, by the absence of signs of toxæmia, by a malpresentation and an unduly high presenting part. If the fœtal head becomes engaged or a radiograph shows that the placenta is certainly situated in the upper uterine segment a firm diagnosis of accidental hæmorrhage can be made.

The danger of vaginal examination, except in the operating theatre with all preparations made for Cæsarean section, has already been emphasized.

After delivery the diagnosis can be confirmed by examining the membranes, as the hole through which the child is delivered is within 7·5 cm. (3 inches) of the placental edge if the case was one of placenta prævia.

Concealed accidental hæmorrhage. The diagnosis must be made from cases of intra-peritoneal hæmorrhage, due to advanced ectopic gestation, to spontaneous rupture of the uterus, or to acute hydramnios. These, although very rare complications of pregnancy, closely resemble accidental hæmorrhage of the concealed variety. They must be diagnosed by the history and on the physical signs present in each case. Other conditions complicating pregnancy, such as torsion of the pedicle of an ovarian cyst, volvulus, intestinal obstruction, acute appendicitis or peritonitis from any other cause, may have to be considered during the early stages of a concealed accidental hæmorrhage.

The most important factor in the prognosis is the degree of shock and its duration. The amount of blood lost will obviously be important. If the uterus starts to contract rhythmically, instead of remaining in spasm, the prognosis is improved, even if the external bleeding increases temporarily when the patient goes into labour. The sooner the uterus is emptied the sooner will bleeding be arrested, and the risks of hypofibrinogenæmia or renal cortical necrosis are reduced.

In cases of revealed hæmorrhage the maternal risk is small, but in severe cases of concealed hæmorrhage the mortality may exceed 10 per cent.

The prognosis for the child is bad. About 80 per cent do not survive. This is due to (a) asphyxia from placental separation; (b) toxæmia; (c) prematurity.

TREATMENT

All cases of antepartum hæmorrhage should be admitted to hospital. In severe cases this is essential, in less severe cases the diagnosis is often uncertain and placenta prævia cannot always be excluded. A vaginal examination should not be made before the transfer of the patient to hospital. In cases with severe shock a blood transfusion and an injection of morphia should be given before moving the patient.

Revealed accidental hæmorrhage. Since this term includes cases which vary in severity from a slight loss of blood to a profuse flooding no single method of treatment will be applicable to all cases.

Cases with slight bleeding. If the amount of bleeding is only slight and the pregnancy is still some weeks short of term there is no need to do more than put the patient at rest. In many cases no further bleeding occurs and the pregnancy continues to term. The appearance of the placenta in such cases will show that part of it has been detached, being brown, shrunken, and more solid than the rest, and having old blood-clot adherent to it.

Cases with more severe bleeding. This group includes cases in which the amount òf bleeding is sufficient to be dangerous or there is any degree of shock. In most severe cases the fœtus is already dead and need not be considered. Only in a few exceptional cases will Cæsarean section be required in the interest of the fœtus. The object of treatment is to get the uterus empty, contracted, and retracted with as little bleeding as possible and without added risk to the mother. This end can best be achieved by allowing the uterus to empty itself. A blood transfusion should be given if the loss is more than slight or there are any signs of shock. If the patient is not already in labour it should be induced by low rupture of the membranes under anæsthesia. This should be done without delay. If regular contractions do not follow an oxytocin drip may be given, but in a few exceptional cases in which profuse bleeding persists the uterus should be emptied by Cæsarean section.

Many cases are already in labour, and labour usually follows induction in the other cases. The second stage of labour may be shortened with the aid of the forceps. The third stage should be conducted with care, an intravenous injection of ergometrine (0·5 mg.) being given immediately after the birth of the head.

Cæsarean section is sometimes justified in the interest of the fœtus. It should never be performed in the presence of severe maternal shock. It would be justifiable in a case with a viable fœtus and fairly severe bleeding. Such cases are not common. Cæsarean section is not required in cases with slight bleeding unless there is evidence of fœtal distress.

Concealed accidental hæmorrhage. Most cases of concealed accidental hæmorrhage are very serious, because the patient is collapsed as a result of the loss of blood and the painful distension of the uterus. The first essential is to treat the shock and not to attempt to deliver the child before this has been done. A 'flying squad' should be called.

The patient must be given an immediate injection of morphia, 15 mg. (gr. $\frac{1}{4}$). The foot of the bed may be raised. The room should be as quiet as is possible and the patient should not be moved until severe shock has been treated by blood-transfusion and the injection of morphia, but transfer to hospital will be required, and should not be long delayed. If the patient's condition is poor and facilities for blood-transfusion are not available, dextran or other plasma substitute may be used, or failing that, intravenous saline, but dextran should not be used until blood is taken for grouping. A note is made of the girth of the abdomen at a marked level and the height of the fundus is likewise marked upon the skin. Following these steps the condition of the patient is observed, hour by hour, and she must not be left. A further injection of morphia (10 mg.), gr. $\frac{1}{6}$ must be given if the pain is not relieved.

As the state of shock passes off improvement usually occurs. Treatment will be influenced by the parity of the patient and by the duration of the pregnancy. The majority of these patients are multiparous women, and as the fœtus is small and premature, an easy quick delivery is to be expected if labour is established. After the initial treatment for shock the membranes should be ruptured. It was formerly taught that the membranes should not be ruptured until the uterus had lost its wooden hardness, as it was feared that further loss of blood would occur from an atonic uterus. There is little ground for this fear, and continued bleeding is more often due to hypofibrinogenæmia, and the danger of this or of renal necrosis is reduced by early rupture of the membranes and consequent reduction of intrauterine tension.

Surgical treatment by Cæsarean section is now being recommended in some of these cases. The results in the past were poor, because the operation was performed in desperate cases, some of which had received inadequate transfusion, and in some of which hypofibrinogenæmia was present so that bleeding could not be checked even by hysterectomy.

If the operation has any place it must be performed before irreversible shock is established. Most cases respond rapidly to artificial rupture of the membranes; and the operation should only be considered in those in which the patients' condition is deteriorating in the absence of uterine contractions, especially in the case of a primigravida with a tight cervix.

The possibility of hypofibrinogenæmia as a result of concealed accidental hæmorrhage should be borne in mind. It should be suspected in any case of delayed or absent clotting. A fibrinogen estimation should be made and a

critical level is considered to be 100 mg. per 100 ml. It is treated by fibrinogen replacement with blood-transfusion or better still by an infusion of 2 to 10 G. of fibrinogen.

TREATMENT AFTER THE LABOUR IS OVER

The fact that the patient has been delivered after accidental hæmorrhage and that there is no great amount of postpartum hæmorrhage does not necessarily mean that she will do well. In the absence of efficient treatment some of these patients die a few hours after delivery, from heart failure. Such patients should not be left until recovery from shock is complete, as will be indicated by the general condition, the pulse-rate and blood-pressure. An amount of postpartum hæmorrhage which would be trifling in the case of a robust woman may be of grave consequence in the case of a patient who has had severe antepartum hæmorrhage.

It is important to continue with blood transfusion until the patient's condition is restored to normal or until the total blood loss has been made good. Bleeding in the third stage must be controlled by ergometrine intravenously during delivery and intramuscularly afterwards.

Renal cortical necrosis and lower nephron nephrosis

A rare but serious complication of accidental hæmorrhage, particularly of the concealed variety, is renal failure or extreme oliguria. (Similar anuria may also ocuur as a very rare complication of eclampsia, abortion, or traumatic delivery and postpartum hæmorrhage. Indeed, anuria of this type is not confined to pregnant women; rare cases have occurred in men and women who are not pregnant, after acute infection, exposure to various toxins, and traumatic shock.)

PATHOLOGY

In fatal cases one of two pathological conditions is found, either renal cortical necrosis or lower nephron nephrosis. In *renal cortical necrosis* both kidneys show uniform symmetrical necrosis of almost the entire cortex; only a thin layer under the capsule survives. The zone of necrosis involves nearly all the glomeruli and a large part of the tubular structure. In *lower nephron nephrosis* the kidneys may appear normal to the naked eye, but microscopical examination reveals widespread necrosis and degeneration of the second convoluted tubules and collecting tubules. The glomeruli are not involved.

The mode of production of these two pathological conditions has been much disputed, and it is still uncertain whether they are not different degrees of one pathological change. Renal cortical necrosis is due to

ischæmia; the blood-flow through the cortex ceases. Trueta has brought evidence to show that there is an arterial shunt in the kidney which regulates the blood-flow through the cortex. When the shunt is closed the blood flows through the intralobular vessels to supply all the cortex (except a thin lamina which gains its blood-supply from the capsule). When the shunt is open the blood returns to the veins by an alternative pathway which diverts it from the cortex. It is suggested that this shunt is brought into operation in cases of concealed accidental hæmorrhage by toxic substances which pass into the blood-stream, and perhaps also by nervous stimuli from the uterus along sympathetic pathways. Although the details of this theory are not universally accepted, it is at least certain that cortical necrosis is due to ischæmia. The changes are irreversible and inevitably fatal.

The cause of the changes of lower nephron nephrosis is less certain. The changes have been attributed to the direct action of a toxin, or alternatively to ischæmia. It is difficult to explain the escape of the glomeruli and the selective effect on the second convoluted tubules on either hypothesis. It is believed that regeneration of the damaged tubules can occur, and that the cases of obstetric anuria which recover are of this nature.

CLINICAL FEATURES

The initial clinical features of anuria due to cortical necrosis and lower nephron nephrosis are identical. After recovery from shock, or after delivery, the first danger sign is the passage of a few millilitres of blood-stained urine. Complete, or nearly complete, anuria follows and only a small quantity of very dilute urine is passed. The patient remains well for several days, during which time the blood-urea rises progressively. In fatal cases, after about 10 days, drowsiness and twitching movements appear, and death quickly follows the appearance of these signs. In other cases, spontaneous diuresis occurs after about a week, and rapid and apparently complete recovery occurs. It is believed that the cases which recover are due to lower nephron nephrosis.

TREATMENT

Since there are no means of distinguishing the fatal cases of cortical necrosis from the cases of lower nephron nephrosis in which recovery may occur, the only possible course is to treat all cases alike, and hope that spontaneous diuresis will occur. Many patients have been killed by injudicious treatment, particularly by giving large volumes of fluid intravenously. Diuretics are useless and harmful, and such surgical procedures as decapsulation of the kidneys or splanchnic block probably only add

further pain and disturbance to the patient's illness. Although some cases treated surgically have recovered, they might well have done so in any event, and equally frequent and dramatic recoveries follow the simple treatment now to be described.

In anuric patients the only loss of water which is taking place is in the breath, sweat and fæces, and this is less than 1 litre per diem. Unless there is additional loss by vomiting the total fluid intake should never exceed this. Since the metabolism of fat in the body provides as much as 400 ml. of water a day the intake should be restricted to about 600 ml. Disturbance of electrolyte balance also occurs, but in the absence of normal renal function it is highly dangerous to give electrolytes which can so easily be given to excess. The temporary disturbance of balance will neither interfere with spontaneous diuresis, nor will it be of a degree to kill the patient before spontaneous diuresis occurs.

Since breakdown of protein of food may liberate potassium ions, and possibly other toxic substances, protein is excluded from the diet, and a large amount of carbohydrate is given to reduce the breakdown of tissue protein. The diet is nauseous, and for that reason is given by gastric tube or intravenously. Bull, Joekes and Lowe summarize the oral treatment thus: 'On admission of the patient to hospital a stomach-tube is passed through the nose. Through this tube the following mixture is dripped at a steady rate through the 24 hours: glucose 400 g., peanut oil 100 g., acacia q.s. to emulsify . . . water 600 ml. All vomit is collected, filtered through lint and returned to the stomach in the same way. This ensures that the fluid intake is accurate, that there is no loss of food by vomiting, and that no loss of electrolytes occurs through vomiting. . . . When diuresis starts urinary losses of the various electrolytes must be made good quantitatively and to the basic intake of 600 ml. of water, fluid is added daily in a volume equal to the urine passed in the preceding 24 hours. It is desirable that the drip feeding should be discontinued and superseded by a low protein diet when the urine output exceed 1 litre a day.'

Bull's regime can be conducted by giving intravenous glucose via a catheter introduced through the femoral vein and pushed up to the inferior vena cava. This avoids the common difficulty of thrombosis of superficial small veins which so often occurs with prolonged infusion of glucose solutions.

In cases showing clinical deterioration or with a high concentration of urea or potassium in the blood dialysis by means of the artificial kidney is used.

It is suggested that norethandrolone—a synthetic anabolic steroid, which reduces the metabolic response may largely eliminate the need for dialysis in acute reversible renal failure occurring as a complication of pregnancy.

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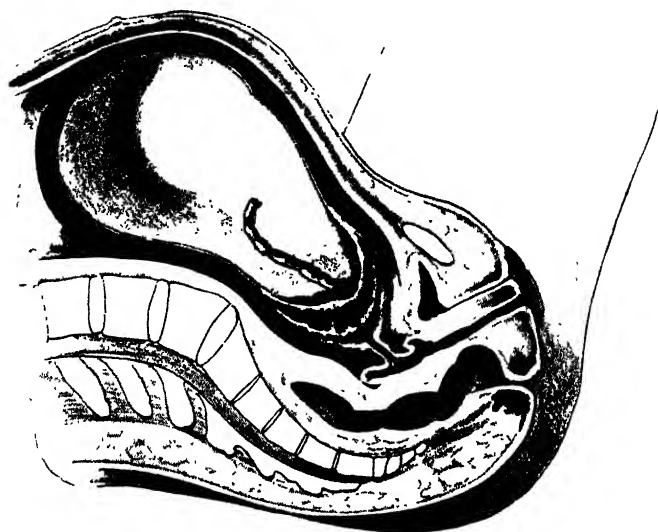
FIG. 175.   Complete placenta prævia.
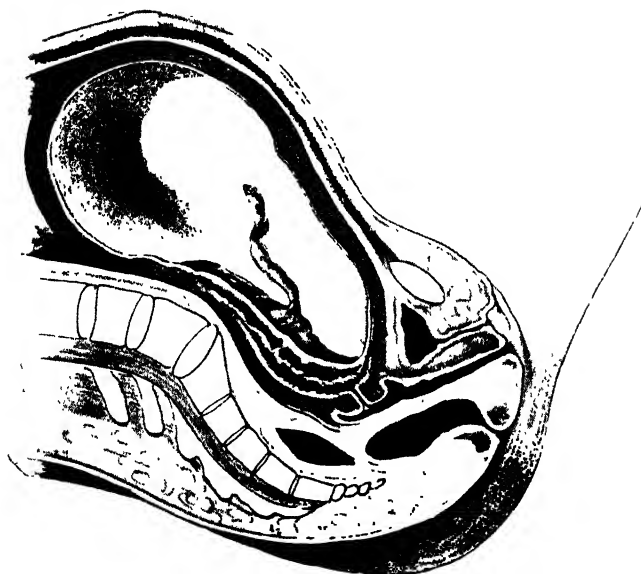
FIG. 176.   Marginal placenta prævia.

The placenta is on the lower uterine segment and extends to the margin of the internal os.

PLACENTA PRÆVIA (UNAVOIDABLE HÆMORRHAGE)

DEFINITION

A placenta is described as prævia when it is wholly or partly attached to the lower uterine segment.

VARIETIES

1. **Complete or central** when the placenta covers the internal os uteri (Fig. 175).

2. **Incomplete** when the placenta does not cover the internal os uteri. There are two varieties of incomplete placenta prævia.
(*a*) Marginal, when the placenta comes down to the internal os (Fig. 176).
(*b*) Lateral, when the placenta does not reach as low as the internal os, but is situated partly on the lower uterine segment (Fig. 177).
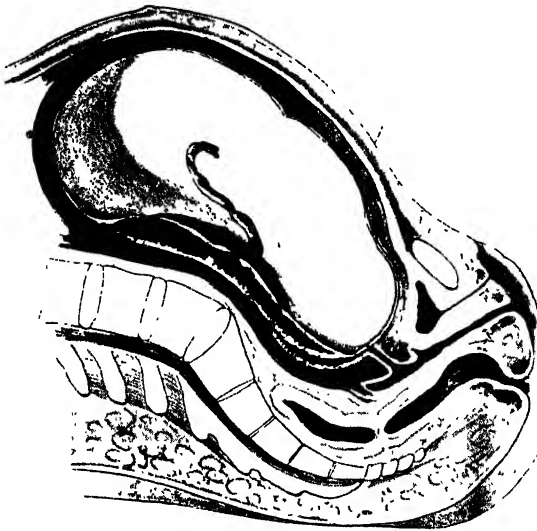
FIG. 177.   Lateral placenta prævia.
The placenta is on the lower uterine segment, but does not reach the undilated internal os.

There is a tendency to discontinue the use of the terms central, lateral and marginal, as confusion has occurred because the terms 'lateral' and 'marginal' have not been used consistently by medical writers.

A classification has been suggested to replace the old terms and is illustrated (Fig. 178). It will be seen that the classification depends on observations made on examination with the finger, but it must be repeated

that such examination can be extremely dangerous, and should only be made with the patient anæsthetized on the operating table and with all preparations made for Cæsarean section.
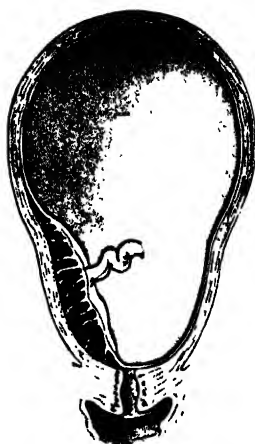
Type I   Type II
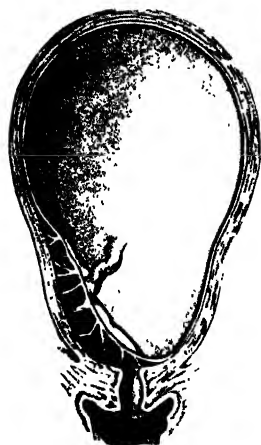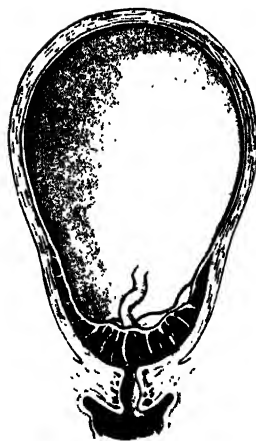
Type III   Type IV

FIG. 178. Classification of degrees of placenta prævia.

Type I. The placenta is only partly attached to the lower uterine segment; its lower margin dips into the lower segment but it cannot be easily reached by the examining finger through the non-dilated internal os. (This is the lateral placenta prævia.)

Type II. A greater part of the placenta is attached to the lower uterine segment so that its lower margin reaches down to the internal os. (This is the marginal placenta prævia.)

Type III. The placenta completely overlies the non-dilated internal os, but the lower margin is still within reach of the examining finger.

Type IV. placenta overlies the non-dilated internal os and the margin of the placenta is too far from it to be reached by the examining finger. (Types III and IV include the cases of central or complete placenta prævia.)

The findings in any given case will vary with the degree of dilatation of the cervix, and a case which may appear complete when the internal os will only admit the finger tip may later be found to be incomplete when further dilatation allows the edge of the placenta to be felt.

PATHOLOGY

Placenta prævia occurs about once in 500 labours, and is most common in women who have had a number of children.

Pathological anatomy. The placenta is irregular in shape and variable in thickness. It may cover a larger area than normal and is often pathologically adherent in part. These changes are explained by the comparatively poor blood-supply which the placenta obtains from the non-vascular lower segment. The cord frequently has a marginal insertion. The lower segment of the uterus and the cervix are softer and more vascular than usual, in consequence they tear more readily.

Cause of the hæmorrhage. The hæmorrhage comes from the maternal blood-vessels in the lower segment, which are opened up by the separation of the placenta as the lower segment dilates. Except in cases in which the placenta is torn during manipulations, there is no hæmorrhage from the fœtal circulation.

SYMPTOMS AND COURSE OF LABOUR

At full time, or more frequently during the last 3 months of pregnancy, the patient notices slight hæmorrhages from the vagina. They come on without apparent cause, perhaps in the middle of the night, but, as in accidental hæmorrhage, they may follow hard exercise or trauma. Though repeated slight hæmorrhages commonly occur, the first bleeding may be a severe one. Pain is not experienced.

Severe hæmorrhage is inevitable during cervical dilatation in labour.

The third stage of labour is liable to be complicated by immediate and recurrent postpartum hæmorrhage because the area of placental attachment is larger than normal and because it covers a variable amount of the lower uterine segment which does not undergo efficient retraction. In

addition, bleeding from any lacerations of the cervix may be expected to be more severe owing to the increased blood-supply to the lower segment.

DIAGNOSIS

A history of repeated losses of blood, small in amount at first but usually increasing, is strongly suggestive of placenta prævia.

On abdominal examination, an indication of the nature of the case may be obtained from finding the child lying obliquely or its head above the brim of the pelvis, or presenting by the breech, because the placenta is filling the lower segment. Otherwise the uterus is normal on palpation. The urine will probably not contain albumin.

On vaginal examination, the soft spongy mass formed by the placenta may be palpable through one of the fornices, or the head, if presenting, may be felt plainly through one fornix and indistinctly through the other. A certain diagnosis can most easily be made by feeling the placenta with a finger passed through the internal os. *This may be followed by furious bleeding, and it should only be done in an operating theatre when the patient can be treated immediately by whatever method is thought advisable.* In many cases the other clinical evidence can be confirmed by radiological examination, so that digital examination can be avoided.

In cases with slight bleeding it is safe to inspect the cervix with a speculum to exclude any incidental cervical cause of bleeding. However, if an erosion is found this does not exclude placenta prævia, and only if any other cervical lesion is evidently bleeding should it be accepted as the cause of antepartum hæmorrhage.

Determination of the situation of the placenta by radiography. An attempt should be made, except in the case of patients who are bleeding heavily and for whom immediate treatment is required, to localize the position of the placenta by soft-tissue radiography. The degree of success attained depends on the keenness and interest shown by the radiologist, radiographer and obstetrician in the unit concerned.

An erect lateral film of the abdomen may demonstrate the placenta as a shadow, which may show flecks of calcification, on the anterior or posterior wall of the upper segment, in which case there can be no placenta prævia. If there is a placenta prævia engagement of the head is prevented and the head is displaced forwards or backwards. Provided that the vertex presents, an erect lateral film will show displacement of the head away from the promontory or from the symphysis. An anterior placenta prævia will hold away the head, which should normally rest by gravity on the symphysis. With a posterior placenta prævia it is impossible to close the gap between the head and the promontory by reclining the patient backwards. Only

two exposures are necessary as a rule, and this simple technique is of great help in the diagnosis of placenta prævia (See Fig. 179).
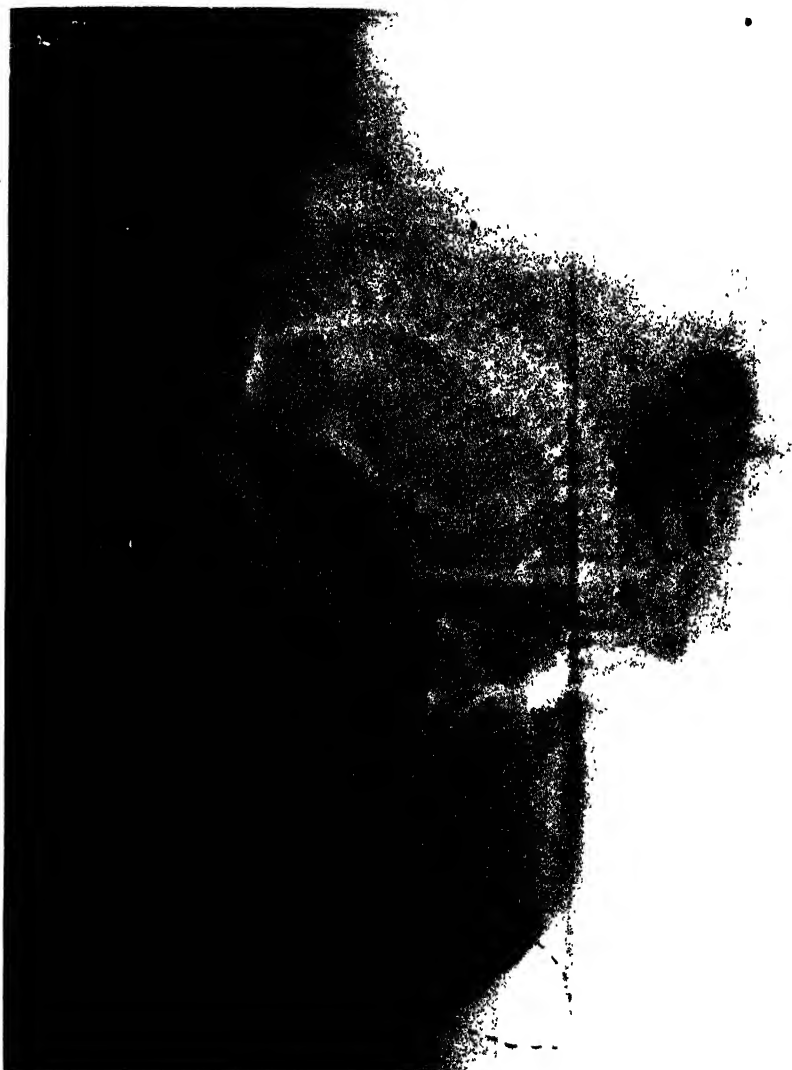
FIG. 179. Placenta prævia. The bladder contains 20 cc. of opaque fluid. The greater part of the placenta was on the left side.

PROGNOSIS

Maternal. The prognosis will largely depend on the amount of hæmorrhage, which is always greater with a complete than with an incomplete

placenta prævia. The earlier the diagnosis is made the sooner can the patient be put into surroundings in which efficient surgical treatment can be adopted. Early diagnosis is most important as many of the fatal cases have bled severely, or have already been infected, before any skilled treatment can be carried out. The prognosis is much more serious in a primigravida with an unyielding cervix than in multipara. When the uterus is contracting, treatment is urgently called for as the bleeding will continue and probably increase in amount. The prognosis is much more serious if the patient has to be dealt with in her own home and not in an institution. Series of cases from institutions show a mortality of under 1 per cent.

The chief causes of maternal death in placenta prævia are hæmorrhage and shock. Hæmorrhage may be both antepartum and postpartum.

Postpartum hæmorrhage may occur from uterine inertia, from the large size of the placental site, from the placenta being situated low down where the retractile power of the uterus is weaker, and from lacerations of the vascular cervix. A small postpartum hæmorrhage may be fatal to an exsanguinated patient.

Sepsis is now rare, but was formerly common because of vaginal manipulations which were carried out near the low-lying placental site.

Fœtal. Unless Cæsarean section is performed or unless the placenta prævia is of the lateral type, the outlook for the child is bad. The causes of fœtal death are, asphyxia due to lack of oxygen from pressure upon or separation of the placenta, pressure on the umbilical cord, and prematurity. Severe maternal shock and anæmia also cause fœtal anoxia.

Fœtal hæmorrhage may occur from the separated placenta or from cutting or tearing the placenta at Cæsarean section and may cause anæmia in the new-born infant which calls for blood transfusion.

TREATMENT

If placenta prævia is diagnosed or even suspected, the patient should be moved as soon as possible to an institution unless the loss has been severe. If the patient is bleeding severely in her own home when first seen she should be given morphia (15 mg.) gr. ¼ and the doctor should send for the obstetric flying squad, the members of which will be able to treat the patient for her blood loss. *It is most important that no vaginal examinations should be made or plugging introduced into the vagina before transfer to hospital, as such an examination may cause further serious hæmorrhage.* The patient's condition may allow her to be moved immediately by ambulance or only after her condition has improved after blood transfusion. On admission to an institution the patient should have her blood grouped if this has not already been done.

In all cases with severe bleeding immediate active treatment is required and delay is perilous. But the chief cause of fœtal mortality in cases of placenta prævia is prematurity, and if the bleeding is only slight and the fœtus is some weeks premature then the risk of keeping the patient in bed while the fœtus grows is justifiable, provided she is in a hospital where treatment by transfusion and operation is immediately available should severe bleeding occur. This expectant attitude has greatly reduced the fœtal mortality in recent years without increasing the maternal mortality.

If bleeding is severe or persistent a blood transfusion is started at once, and it will be necessary to perform a Cæsarean section, especially if the patient is a primigravida and the cervix is closed. The exact position of the placenta is of no importance and digital examination is dangerous and unnecessary. Section should still be performed if the fœtus is premature or dead; the purpose of the operation is to control the hæmorrhage by emptying the uterus and allowing it to retract.

If the bleeding is slight, or there has been time for investigation, it is usually possible by clinical and radiological methods to make a diagnosis without attempting to feel the placenta through the cervix. This may, however, be done if the diagnosis is doubtful. It must only be done in the operating theatre with the patient anæsthetized and the instruments ready for Cæsarean section. A finger is passed very gently through the cervix. If a placenta of Type II, III or IV is encountered Cæsarean section is performed, but if the placenta is of Type I (lateral) low rupture of the membranes may be performed, which allows the presenting part to descend and compress the lower margin of the placenta and control the bleeding.

Cæsarean section should not be performed until shock has been corrected. If the placenta lies anteriorly some obstetricians perform classical Cæsarean section as there may be severe bleeding from large vessels in the lower segment and from the placenta during the lower segment operation. Nevertheless, it is found in practice that a lower segment operation can usually be safely performed. Injury to the placenta may cause fœtal bleeding, so the cord should be clamped without delay.

Other methods of treatment. In this country almost all cases are within reach of hospital facilities, so that other forms of treatment are very seldom employed, though they may still be mentioned for the benefit of the occasional patient for whom proper obstetric care is unobtainable or for whom Cæsarean section cannot be performed. These older methods are less effective in controlling hæmorrhage, are more often followed by infection, and give worse fœtal results than the methods already described.

The principle involved in the control of bleeding in these methods is pressure on the placental site by the presenting part. The simplest means is artificial rupture of the membranes, which, combined with the application

of an abdominal binder allows the head to descend. This operation is often successful with a lateral (Type I) placenta prævia in multiparæ.

The application of Willett's scalp forceps to the fœtal scalp with traction by a weight of about one pound may be used, if the bleeding is not controlled by artificial rupture of the membranes. This method entails the minimal amount of interference and therefore less risk of sepsis.
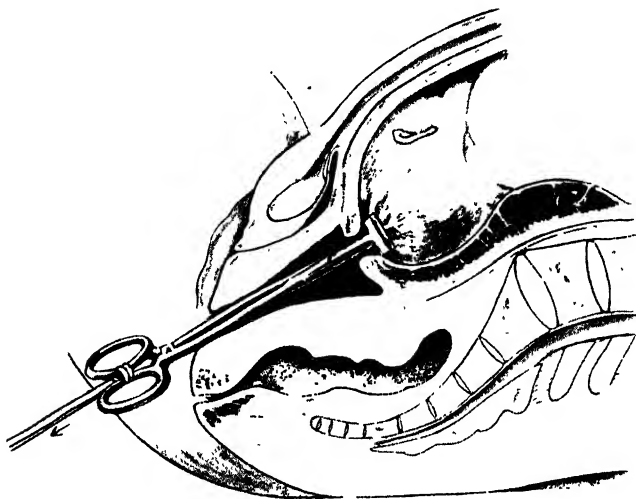
FIG. 180. Willett's forceps making traction on the head in a case of placenta prævia. Type II.

Weight traction of 1 lb. should be applied to the forceps.

If facilities for Cæsarean section are not available in cases in which the bleeding is severe and the placenta either completely or partially covers the internal os (Types III and IV), more active treatment is indicated. This will vary according to the size of the os.

Plugging the vagina is useless. It does not always stop bleeding from placenta prævia and may deceive the attendant by hiding some of the blood loss. The plug is painful, difficult to insert, increases the danger of sepsis and sooner or later it has to be removed. If the patient is in labour with a cervix half-dilated and the breech presenting it may be good practice to pull down a leg to plug the lower segment while the uterus contracts and dilates the cervix. This treatment carries a high fœtal mortality.

Whatever treatment is adopted blood-transfusion should be freely employed, for although the patient may recover from the initial hæmorrhage, the possibility that further bleeding may occur in the third stage must be anticipated by replacing blood loss in good time.

POSTPARTUM HÆMORRHAGE

DEFINITION

POSTPARTUM hæmorrhage is excessive bleeding which takes place from the genital tract after the birth of the child. A loss in excess of 20 ounces, occurring within 24 hours of delivery, is the standard adopted in Great Britain; a more realistic figure of 500 ml. is likely to be adopted internationally. Postpartum hæmorrhage is classified as Primary, or immediate, and Secondary, occurring more than 24 hours after delivery.

Two types of primary postpartum hæmorrhage are recognized:
1. Hæmorrhage from the placental site (atonic hæmorrhage).
2. Hæmorrhage from lacerations of the genital tract (traumatic hæmorrhage).

Of these the former is the more commonly met with and the more serious. If any patient is losing blood steadily in the third stage of labour immediate steps must be taken to stop the bleeding and to treat any shock.

Hæmorrhage from the placental site

PATHOLOGY

The mechanism by which the blood-loss is normally controlled is by the retraction of the uterine muscle fibres. These muscle fibres which surround the vessels in the wall of the uterus compress their lumina by retraction and thus the hæmorrhage is checked. Until the blood clots in these vessels hæmorrhage is prevented by this retraction being maintained.

It is impossible for the placenta to separate without exposing the open mouths of the maternal sinuses in the uterus and thus some blood must escape during the third stage of labour. In this way a loss of 250 ml. (8 oz.) usually occurs in a normal labour. Although it is customary to regard a loss of 0·5 litre (1 pint) and over as pathological, any loss which appears excessive to the observer must be treated as postpartum hæmorrhage.

CAUSES

1. *Weak uterine contraction and retraction.* Weak contraction of the uterus in the third stage of labour may fail to separate the placenta completely, so that it remains in the upper segment and prevents effective retraction of the placental site. In other cases, even though the placenta has been completely

separated and has been expelled, severe hæmorrhage occurs if the uterus fails to maintain its retraction.

If the uterus is not completely empty retraction will be ineffective. Although it is true that a very strong contraction, for example after the injection of ergometrine, may temporarily control bleeding even if the placenta is still in the uterus, in cases in which the contractions are less strong the presence of the placenta or a cotyledon or a large mass of blood-clot in the uterus will interfere with retraction. Uterine action is also less efficient if the bladder is not empty.

Weak uterine action may occur in cases in which:

(a) There has been a long labour, especially in cases due to weak or inco-ordinate uterine action, but also in cases of long labour due to mechanical difficulty if uterine exhaustion occurs.

(b) Prolonged or deep anæsthesia has been administered.

(c) The uterus has been overdistended by hydramnios or multiple pregnancy. In twin pregnancy the placental site is also larger than normal.

(d) The patient is a multipara with an atonic uterus.

(e) The uterus is atonic because of concealed accidental hæmorrhage.

2. *Mismanagement of the third stage of labour.* After a normal delivery, if ergometrine has not been injected at the end of the second stage, the uterus remains at rest for a few minutes. The placenta is still completely attached, and no bleeding occurs. But if the uterus is squeezed during this interval the placenta may be partly separated, and bleeding begins and must inevitably continue until uterine contractions complete the separation and allow proper retraction to follow. Such injudicious attempts to expel the placenta before normal separation has occurred, and in the absence of uterine contractions, are a common cause of postpartum hæmorrhage.

3. *Placental abnormalities.* In rare instances the placenta may be abnormally adherent, sometimes because the chorionic villi have penetrated more deeply than usual and entered the muscle wall (placenta accreta). If such a placenta is only partly separated it will remain in the upper segment and interfere with retraction.

In cases of placenta prævia the placenta may have a wider area of attachment than normal, and the lower segment may fail to retract strongly enough to control the bleeding effectively.

4. *Hypofibrinogenæmia* is an occasional cause of severe postpartum hæmorrhage. The fibrinogen available in the blood is so deficient that clotting is delayed or does not occur. It is especially associated with concealed accidental hæmorrhage, but it also occurs in cases of retention within the uterus of a dead fœtus for many weeks and in amniotic embolism.

In accidental hæmorrhage the liberation of thromboplastin from placental tissue into the blood-stream uses up the fibrinogen. In amniotic embolism the fibrinogen may be rapidly used up by the same mechanism. .

DIAGNOSIS

In the great majority of cases in which blood is issuing from the vulva the question to be decided is whether the blood is coming from the placental site or from lacerations, but in rare instances severe bleeding may take place into the cavity of an atonic uterus without much appearing externally. If the third stage is correctly* conducted, with the left hand on the abdomen, softening and enlargement of the uterus will draw attention to the blood inside the uterus.

SYMPTOMS AND SIGNS

The symptoms and signs are those of hæmorrhage. The observation that the patient is bleeding excessively is enough. The blood-pressure is low. In very severe cases, pallor, a rapid pulse rate and air hunger occur.

PROGNOSIS

The immediate prognosis depends on the rate at which the blood is lost, the amount of the blood-loss and the condition of the patient prior to the loss.

Owing to the increase in the total quantity of blood during pregnancy, a parturient patient stands hæmorrhage comparatively well, and may recover when some pints have been lost, provided the loss is not too rapid. On the other hand, a patient who is already exsanguinated by an antepartum hæmorrhage will rapidly die if even a small quantity of blood is lost after delivery; and, in a similar way, a comparatively insignificant secondary postpartum hæmorrhage may turn the scale against a patient who has lost freely at the time of delivery.

Postpartum necrosis of the anterior lobe of the pituitary gland is a rare sequel in cases of severe hæmorrhage in which the blood-pressure has remained at a low level for some time (see p. 477).

TREATMENT

Prophylactic treatment. The prophylactic treatment of postpartum hæmorrhage is a matter of great importance. Anæmia must be treated during pregnancy because if an anæmic patient suffers from excessive blood loss it is likely to be far more serious than would be the same loss occurring in a normal patient. Some patients give a history of postpartum hæmorrhage occurring in one or two previous labours. Such cases should be admitted to hospital for delivery. Although investigation of the bleeding

time and clotting time of the blood may be a wise precaution, these tests usually reveal nothing abnormal. In cases of concealed accidental hæmorrhage or intra-uterine fœtal death, fibrinogen or concentrated plasma should be available.

Many cases of postpartum hæmorrhage can be avoided by the proper conduct of labour. In the first stage of labour it is important in cases of slow labour to give adequate sedation and to prevent the patient becoming exhausted. In the second stage, immediate instrumental assistance should be given if the uterine contractions are becoming less efficient. The proper conduct of the third stage is the most important single item in the prevention of this complication, and the correct use of ergometrine will greatly reduce the amount of blood lost (see p. 153).

The student should refer to the account of the management of the third stage of labour on p. 148 for details of the conservative and the active methods.

The best method is to give intravenous ergometrine with the birth of the anterior shoulder. This usually results in the delivery of the placenta in 5 minutes with very slight blood-loss. If the injection is given before the delivery of the anterior shoulder there is the danger of the uterus acting too powerfully on the child.

In domiciliary practice a midwife working alone may find it impossible to give her patient an intravenous injection and for such cases an intramuscular injection with hyalase has the advantage of saving two minutes which may be of vital importance.

Ergometrine should be ready in a syringe before every baby is born and should be given intramuscularly if it has not been given intravenously or in cases in which hæmorrhage continues after the delivery of the placenta. If intramuscular ergometrine is given after the baby is delivered there is a danger of the placenta being retained by a contraction ring or tonic uterine contraction.

Ergometrine should not be used in cases of twins until the delivery of the second baby, nor in cases of very powerful uterine action.

Therapeutic treatment. Two principles govern the treatment of postpartum hæmorrhage: the hæmorrhage must be arrested and the circulating blood volume must be restored. The medical practitioner may occasionally be called to an emergency case in which such severe bleeding has already taken place that the patient is exsanguinated when she is first seen. In such cases the services of a flying squad should be demanded.

Bleeding ceases when the uterus strongly contracts, and is empty. The best way of achieving this aim will depend on the following factors:

1. Whether the placenta has been delivered or not, and if not, whether it has already separated.

2. Whether the patient has already been given an injection of ergometrine.
3. Whether the patient is in a well equipped hospital or elsewhere.

In England and Wales and most parts of Scotland there are few places without a flying squad being available within 30 minutes. The flying squad is composed of an obstetrician, anæsthetist and nurse equipped with all that is necessary for blood-transfusion, resuscitation and such obstetric operations as are immediately necessary. When a patient has postpartum hæmorrhage which the midwife or doctor is not able to control, the flying squad should be sent for. The patient will receive immediate attention at

FIG. 181.   To show Credé's method of expressing the placenta by squeezing the uterus.

home. A patient should not be moved to hospital until she has been given blood; the placenta has been removed and the bleeding has ceased. If the patient is moved to hospital with the partially separated placenta in the uterus she may die on the journey from hæmorrhage.

(a) *Bleeding before the birth of the placenta.* If the placenta is still un-delivered the patient is turned upon her back, the left hand is placed on the abdomen, the uterus is gently rubbed until it becomes firm, and then the fundus is palpated to determine whether the placenta has separated or not (see p. 148 for the signs of separation). If the placenta has separated it can

easily be expelled by backward and downward pressure on the contracted fundus. Traction on the umbilical cord is also permissible at this stage to deliver the placenta from the lower uterine segment and vagina.

If the placenta has not separated the management of the case is far more difficult. If the uterus is contracting the Brandt-Andrews method of delivering the placenta may be tried (see p. 152). This method is not undertaken if the uterus is relaxed because of the risk of inverting the uterus. Squeezing the uterus to separate the placenta from its attachment in the upper segment is spoken of as Credé's expression. It is carried out by placing the fingers on the posterior wall and the thumb over the fundus on the anterior wall, as shown in Fig. 181. After rubbing up a contraction the uterus is squeezed firmly; it is important to squeeze the uterus and not to push it into the pelvis. It is usual for right-handed people to do this with the left hand, keeping the right hand sterile and ready to carry out any further manipulation. The uterus must not be squeezed or pressed upon while it is relaxed for fear of inverting it.

Credé's method should only be employed if the uterus can first be made to contract. If it is used on a soft uterus inversion may occur. The method has become unpopular because of its limited use, because manual remova of the placenta is now relatively safe and easy, and because Credé's method is often used wrongly, repeatedly and forcibly, when it causes pain, shock and a waste of valuable time. In many hospitals its use is completely forbidden. Nevertheless, if properly performed it can be life-saving in a case of severe bleeding. If it is not immediately successful at the first attempt it should not be tried again. An anæsthetic should be given and the placenta removed manually.

Manual removal of the placenta is performed by passing the right hand into the uterus and following the cord up to the placenta. The left hand is kept on the abdominal wall, and serves as a guard against the risk of perforating the uterus with the internal hand. The edge of the placenta is identified, and then the placenta is gradually separated with the fingers. Only when it is completely free should any attempt be made to withdraw it. After separation of the placenta its site of attachment will remain as a raised and rough area, and the inexperienced operator must not mistake this for a piece of retained placental tissue.

In the past manual removal of the placenta performed on a shocked patient, with no anæsthesia or inadequate anæsthesia was a very frightening and hazardous operation and accompanied by grave risks of infection. Now the operation is usually done with adequate anæsthesia on a uterus contracting under the influence of ergometrine, and the fear of subsequent infection—while not removed—is minimized by blood-transfusion and antibiotics. Therefore, it is now common practice to have recourse to manual removal of the placenta at once if cord traction or Credé's method

fails in a case of postpartum hæmorrhage. When this is done it is often found that the placenta is partially adherent near a cornu, or retained by a contraction ring.

(b) *Bleeding after the birth of the placenta.* If bleeding takes place after the placenta has been delivered and the patient has not already had an injection of ergometrine this should be at once given intravenously (0·5 mg.). The uterus should be rubbed gently to stimulate a contraction, and
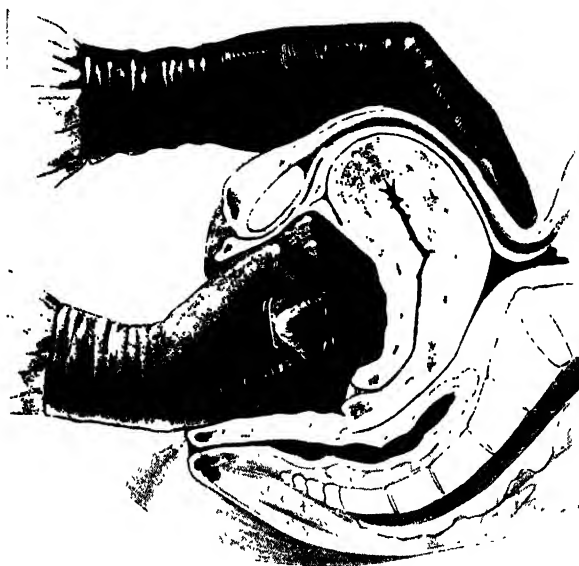
FIG. 182.   Bimanual compression of the uterus.

In the illustration the operator is standing between the patient's legs. For this the patient must be placed across the bed with her buttocks resting on the edge. Bimanual compression can be performed equally well with the patient lying on her back in the bed in the ordinary position. In these circumstances it is obviously easier for the operator to place his right hand in the vagina and his left on the patient's abdomen.

any contained blood-clot expelled. The placenta should be examined carefully in case a cotyledon is missing. If so it should be removed manually under an anæsthetic. If the bleeding continues, bimanual compression of the uterus should be performed immediately (Fig. 182). This is carried out as follows: one hand is inserted into the vagina, then closed so as to make a fist with the back of the hand directly posteriorly and the knuckles in the anterior fornix; the other hand is placed on the abdomen resting on the posterior surface of the uterus and the anteverted uterus is pressed down on to the fist in the vagina. In this way the posterior wall is pressed against the anterior, and the hæmorrhage checked. *In cases of severe bleeding it*

should be performed as soon as the placenta is removed, without wasting time on less effective methods of treatment and while waiting for the ergometrine to act. Compression properly carried out is most effective. It should be kept up until the uterus retracts; however, it is tiring to perform, and after a quarter to half an hour, an assistant may be required to replace the obstetrician in order to maintain continued firm pressure. It is also possible in patients whose abdominal wall is lax to compress the uterus between two hands both applied through the abdominal wall.

Occasionally after bimanual compression has been performed and after ergometrine has been injected, the uterus appears to be unable to maintain its tone with the result that hæmorrhage recurs. In this event, injection of the ergometrine must be repeated. In very severe intractable cases a hysterectomy has to be performed as the only way of stopping bleeding. However, by the time a decision has been made to operate it is usually too late.

Treatment of the collapse caused by hæmorrhage. If the patient's pallor, rapid pulse-rate and low blood-pressure show that the bleeding has been sufficient to cause circulatory collapse blood-transfusion is urgently required. If the patient's blood-group is not already known there will not be time to determine her rhesus group, and in a real emergency rhesus negative blood should be used. Most obstetric hospitals are able to obtain Group O rhesus negative blood in an emergency, but in every case a direct agglutination test of the donor's corpuscles and the patient's serum is essential. In domiciliary practice a flying squad should be summoned. If blood is not immediately available one of the modern plasma substitutes should be given, or failing that, intravenous normal saline (gr. 60 of salt to the pint of sterile water, or 9 grammes to the litre).

Dextran should not be used if hypofibrinogenæmia is suspected. If it is used in other cases blood must first be taken for grouping and cross-matching, as the dextran may interfere with the accuracy of the matching. Dextran may delay coagulation by dilution of the already decreased fibrinogen content and by encouraging the precipitation of fibrinogen as fibrin or by forming a fibrinogen-dextran compound.

Citrated blood only replaces blood loss, not fibrinogen loss, and so is wasted if used alone in cases of hypofibrinogenæmia.

The patient must be kept quiet with her head low, so that the failing circulation supplies the medulla with blood. If she is uncontrollably restless an injection of morphia is given, but this is otherwise undesirable as it will still further depress the shallow respiration. Oxygen can be administered.

Hæmorrhage due to clotting disorders. Very occasionally it is found that although the uterus is empty and apparently well contracted there is still a steady trickle of blood from the vagina. This blood remains fluid and

blood that is withdrawn from a vein and allowed to stand does not clot. The causes of incoagulable blood include hypofibrinogenæmia and excess of fibrinolysin in the blood. Treatment consists of the transfusion of fresh blood to restore blood volume, the infusion of 2 to 10 g. of fibrinogen or triple or quadruple strength plasma for hypofibrinogenæmia, and the injection of ε-amino caproic acid to counteract excess fibrinolysin.

Late postpartum hæmorrhage. It occasionally happens that relaxation follows the retraction produced by stimulation of a partly exhausted uterus. The blood may collect inside the uterus. If this should occur the blood must be expelled and the uterus observed carefully. This is done by placing a hand on the fundus and keeping it there for 30 minutes to 1 hour, a precaution which in any case should be observed following any severe postpartum hæmorrhage. Any sign of relaxation can be noticed at once and further loss of blood thus prevented. It is injudicious to leave a patient until her pulse-rate is below 100.

A retained piece of placenta may also cause reactionary or secondary postpartum hæmorrhage, and the placenta should always be examined carefully after delivery to make certain that it is complete. If any part of the placenta is left in the uterus it must be removed manually under anæsthesia.

Secondary postpartum hæmorrhage. This occurs later than 24 hours after the birth of the child and may come on quite late in the puerperium, very commonly about the 10th day. It is usually caused by a retained portion of placenta, or more rarely by fibroids protruding into the uterine cavity. There is, however, another type of secondary postpartum hæmorrhage which occurs in infected cases and is due to the separation of a septic slough. The bleeding may come from the cervix, from a Cæsarean wound, or from the placental site. In these cases there is usually fever, offensive lochia, or other evidence of infection.

Treatment depends upon the cause. When a piece of placenta has been left in the uterus it should be removed by the finger. For about 7 days after delivery it is usually easy to introduce at least two fingers through the cervix, without any instrumental dilatation. In this as in all other intra-uterine operations, counter-pressure must be made on the fundus. A curette may be used lightly to remove small pieces of retained decidua or placenta, and these are often the only abnormal findings. The appropriate antibiotic is given in infected cases. In this type of case if the bleeding is not controlled with ecbolics the cervix should be inspected.

Hæmorrhage from lacerations

A torn cervix may cause persistent hæmorrhage, especially in cases of placenta prævia. Lacerations must be suspected as the source of the hæmorrhage if the loss commences immediately the child is born and continues

although the uterus is retracted. Although such hæmorrhage is rarely profuse, it tends to continue, as it may come from a branch of the uterine artery and may be enough to endanger the patient's life unless stopped.

The ideal treatment is to tie the bleeding point and suture the tear. To suture a deep cervical tear the patient should be put in the lithotomy position, the perineum retracted, and the cervix pulled down to the vulva with a pair of sponge forceps. The split cervix is then stitched with catgut; the highest stitch is the most important, as it will control the cervical branch of the uterine artery from which the blood is coming. If a needle and catgut are not available at once, the hæmorrhage can be stopped by clamping the highest part of the tear in the cervix with a sponge holder. If instruments are not available, pressure should be made on the bleeding point in the tear by a gauze plug in the vagina.

Hæmorrhage may also be due to tearing of a varicose vein in the labium majus, a laceration near the clitoris, a tear of the vagina or of the perineum. A considerable amount of bleeding may occur from a neglected episiotomy incision.

Bleeding from a varix of the vulva is difficult to control with stitches, as each stitch may wound a fresh vein, and so it may be treated by the application of a sterile pad and firm bandage. Tears near the clitoris should be sewn with catgut. Lacerations of the vagina and perineum should be sutured. Mattress sutures may be necessary for very vascular areas.

POSTPARTUM OR OBSTETRIC SHOCK

CAUSES

Shock has been defined as 'a syndrome resulting from depression of many functions, but in which reduction of the effective circulation volume and blood-pressure are of basic importance'.

Some authorities have implied that obstetric shock differs from shock encountered in surgical work. There is no evidence for this, but, there are some conditions causing shock which are peculiar to obstetrics, such as hypofibrinogenæmia and amniotic embolism.

Most cases of shock in obstetrics are associated with severe hæmorrhage, and especially when trauma is added or long and repeated anæsthetics have been given. Severe anoxia during anæsthesia will increase shock.

It has been suggested that shock may occur if the placenta is long retained in the uterus, even in the absence of hæmorrhage. Shock never occurs in such cases, unless unwise and rough attempts to expel the placenta have been made. Shock may be caused by manual removal of the placenta but when bleeding is occurring the placenta must be removed.

In other cases shock may follow prolonged or difficult labour, forcible dilatation of the cervix, difficult instrumental delivery, internal version,

rupture of the uterus, inversion of the uterus, or the use of pitocin. Shock is usually caused by more than one factor, commonly a combination of hæmorrhage, trauma and prolonged anæsthesia, but it may be purely neurogenic and due to fright. Hypofibrinogenæmia is only a special case of hæmorrhage causing shock.

Amniotic embolism may cause shock by producing hypofibrinogenæmia or by causing pulmonary œdema. In this very rare condition a large volume of amniotic fluid enters a vein during the height of a uterine contraction. Immediate respiratory distress occurs with cyanosis and exudation of fluid into the lungs. The diagnosis is often only proven by the discovery of vernix caseosa in the lungs at autopsy.

Very rarely acute adrenal necrosis or hæmorrhage may cause severe shock. Other causes are air embolism, reaction to the transfusion of incompatible blood, and severe clostridial infections.

Treatment. In the treatment of shock it is essential to restore the circulating blood-volume as quickly as possible with blood. Plasma substitutes should only be used if blood is not available and with the precautions already mentioned. As a temporary measure it is best to use intravenous saline while awaiting the arrival of blood. Cases of hypofibrinogenæmia will need the intravenous administration of fibrinogen or quadruple strength plasma. In adrenal failure cortisone must be used. In cases in which the blood-pressure remains low a l-noradrenaline drip should be set up. Oxygen and morphia are valuable.

POSTPARTUM PITUITARY NECROSIS

Severe postpartum collapse due to hæmorrhage may be followed by ischæmic necrosis of the anterior lobe of the pituitary gland. Thrombosis occurs in the vessels which supply the anterior lobe, and necrosis of the whole lobe occurs, except for a thin rim of tissue which may survive at the surface of the lobe. Death may occur soon after delivery, but if the patient survives she will show the clinical picture of Simmonds's disease (pituitary cachexia). All the endocrine functions of the anterior lobe of the pituitary gland are disturbed. There will be failure of lactation due to lack of the lactogenic hormone. Because of lack of thyrotropic hormone the patient becomes lethargic, abnormally sensitive to cold, and usually gains weight. Her basal metabolic rate falls, and her glucose tolerance is increased. Because of lack of corticotrophic hormone she will also have asthenia, a low blood pressure, and will respond poorly to infection. Lack of gonadotrophic hormones will lead to genital atrophy, with superinvolution of the uterus, amenorrhœa, and atrophy of the breasts.

Less severe cases may only have part of this complex clinical picture,

and in very rare instances a further pregnancy has followed, with regeneration of the pituitary gland.

Prompt treatment of collapse due to postpartum hæmorrhage should prevent this disastrous complication. Once the necrosis has occurred substitution therapy may maintain the patient in fair health. For the hypothyroidism thyroxine will be required. For the failure of suprarenal function suprarenal cortical hormones are given. There is no useful purpose in giving gonadotrophic hormones, but testosterone has been found to supplement the action of cortical hormones.

DELAYED DELIVERY OF THE PLACENTA AND MEMBRANES

THE classical signs that the placenta has been separated and expelled from the uterus into the vagina are that the uterus rises, becomes smaller, harder, and more mobile, the umbilical cord lengthens, and slight hæmorrhage occurs from the vagina. Separation of the placenta, which takes place through the decidua spongiosa, begins as the baby is being born and the uterus contracts. The process is normally complete within a few minutes of the baby's birth. Uterine contractions, which are painless, are responsible for expelling the placenta from the upper uterine segment into the lower segment and vagina. Some assistance is needed, however, for the delivery of the placenta from the vagina in the form of straining down by the patient or pressure on the uterine fundus or pulling on the cord by the doctor or midwife.

The time taken for the placenta to be separated from its uterine attachment and expelled from the uterus depends on the force of the uterine contractions and on the firmness of the attachment to the uterus. The retention of the placenta in the uterus for over one hour is regarded as abnormal. However, since there is a risk of hæmorrhage while waiting, most obstetricians prefer to interfere 30 to 45 minutes after delivery of the baby.

CAUSE

Non-delivery of the placenta may be due to inertia of the uterine muscle, a contraction ring in the muscle, morbid adhesion of the placenta to the uterine wall or, in exceptional cases, to rupture of the uterus.

Inertia of the uterus. If the uterus does not contract sufficiently after labour the diminution in size of the placental site will be less than usual, and so the placenta will not become detached so soon as usual. When the uterus has recovered its tone, efficient contraction occurs and the placenta separates. Uterine inertia is sometimes sufficiently marked to cause prolonged delay in the third stage of labour, and at times leads to partial separation of the placenta with hæmorrhage, especially if the delay has led to vigorous and injurious efforts at expression.

Contraction ring, hour-glass contraction of the uterus. This is an occasional cause of delay in the third stage of labour. The contraction ring is most likely to occur after prolonged labour with intra-uterine

manipulations, and may also follow the administration of ergometrine or oxytocin before the uterus is empty. The part above the ring may be relaxed except when the condition is due to oxytocin or ergometrine, the whole uterus then being contracted.

This condition can only be diagnosed on internal examination, by feeling the contraction ring as a tight band constricting the uterus below the placenta. It may be suspected when, in a case of delay in the third stage of labour, attempts to deliver the placenta by the Brandt-Andrews method fail.

Morbid adhesion of the placenta. Normally the placenta separates through the spongy layer of the decidua which is the line of least resistance. On very rare occasions this spongy layer is not formed, and on sections being made of the placental site it is found that the decidua basalis is absent and the villi are in direct contact with the muscle of the uterus (*placenta accreta*). Under such conditions there is no preformed line of cleavage, and the placenta does not separate under the stimulus of normal uterine action. It is then said to be morbidly adherent. The conditions usually follows internal injury to the uterine wall such as may occur at the time of previous intra-uterine manipulation, curettage or Cæsarean section. In some cases the placental tissue has invaded the myometrium and so cannot be removed without injury to the uterus. This condition is called *placenta increta*.

So long as the placenta is everywhere adherent, blood-vessels are not opened and, therefore, blood does not escape; but, if the placenta is adherent over only a portion of its extent, hæmorrhage will occur where separation has taken place. As the presence of the placenta in the uterus prevents complete retraction, hæmorrhage will continue till the whole placenta is separated and delivered.

The diagnosis from contraction ring can be made only by an internal examination showing the absence of any obstruction to the egress of the placenta. On attempting to separate the placenta by the hand it will be found to be densely adherent to the uterus. A placenta succenturiata may be morbidly adherent.

Rupture of the uterus. The placenta may escape through a laceration into the peritoneal cavity, and then its delivery *per vaginam* is impossible. Such cases are very rare, and other more important symptoms of rupture such as abdominal pain, shock and vaginal hæmorrhage are present.

TREATMENT

If delay in the delivery of the placenta is accompanied by bleeding, the treatment will be that of postpartum hæmorrhage before delivery of the placenta (see p. 470).

In cases unaccompanied by hæmorrhage the treatment is not urgent, and extra time must be allowed for the natural processes of separation and expulsion, as the most common cause of the delay is deficient uterine contraction. If from the diminished size, increased mobility, and raised position of the fundus, together with lengthening of the umbilical cord, it is known that the placenta is merely lying in the vagina, it can be pushed out by pressing the fundus downwards, and backwards, the retracted uterus being used as a piston, or by cord traction.

Fig. 183. Manual removal of the placenta.
In this case the separation had begun at the lower edge of the placenta, and so was continued by the fingers up to the top.

Intra-uterine retention of the placenta for more than an hour suggests that either a contraction ring or morbid adhesion of part of the placenta is present, or else the delay is due to uterine inertia. In this case it is desirable that the placenta should be manually removed under anæsthesia. To do this, one hand makes counter-pressure on the fundus of the uterus through the abdominal wall, otherwise the uterus may be torn from the vagina.

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The other hand is inserted into the vagina and follows the umbilical cord up to the placenta. If any portion of the placenta has already separated, a start should be made at that area to separate the rest of the placenta by making a saw-like movement behind it (Fig. 183). If it is very adherent it may have to be removed in pieces, and the membranes stripped off. Instruments must not be used in removing the placenta.

If a line of cleavage cannot be found and the diagnosis of placenta increta is made, there is great danger of perforating the uterus. The safest method of treatment is by hysterectomy, but an alternative method is to leave the placenta *in utero* and await its disappearance by lysis.

If a contraction ring bars the way, the fingers should be withdrawn and two 5-minim (0·3 ml.) capsules of amyl nitrite broken under the anæsthetic mask. This will generally cause relaxation of the contraction ring and the placenta may then be removed manually.

Retention of the membranes. A portion of the membranes may be found to be missing when the placenta is inspected after delivery, but this is not a matter for concern. It is a common practice when delivering them to twist the membranes into a rope; the tension thus produced may be sufficient to separate them if they are only slightly adherent, but if firmly attached this manœuvre has the disadvantage that they become torn at the point of attachment, and thus a portion is retained in the uterus. If the chorion breaks during delivery of the placenta, the lower end of the torn piece may be caught in a pair of artery forceps, by which traction can be made by a rocking movement, when the portion becomes loosened. The retention of a piece of chorion in the uterus does not give rise to any symptoms as a rule; the chorion disintegrates and comes away with the lochia. The possible effects of a retained piece of chorion are subinvolution with persistent red lochia or infection. Of these the last is the only serious sequel and, therefore, the essential thing is a perfect aseptic technique in such a case.

TUMOURS COMPLICATING PREGNANCY, LABOUR AND THE PUERPERIUM

PREGNANCY is occasionally complicated by tumours of the uterus itself or of one of the other pelvic organs or even of the pelvic bones. The more common complicating tumours are:

1. Fibromyomata.
2. Ovarian tumours.
3. Carcinoma of the cervix uteri.

FIBROMYOMATA

Incidence. The incidence of fibroids in association with pregnancy is low; different authors have found an incidence varying between 0·35 per cent and 0·8 per cent. Although this is a low percentage, it is sufficiently high for an appreciable number of cases annually to be seen in a busy maternity department. The incidence is much higher in Negro patients.

Relations of fibromyomata to sterility

Fibroids are very much more common in childless women; whereas the general sterility rate is about 10 per cent, it is 30 per cent in women with fibroids. Moreover those sufferers from fibroids who are not sterile are frequently infertile; the history in such cases is often one of an interval of 5 to 20 years since the last, and often the only, pregnancy.

Effects of pregnancy on fibromyomata

Certain changes commonly occur to fibroids during pregnancy. First, a change in position and, secondly, changes in the fibroids themselves.

1. *A change in position.* Most fibroids grow from the body of the uterus rather then the cervix. As the uterus enlarges corporeal fibroids are carried up into the abdomen, and it is only the exceptional fibroid which grows from the cervix which remains in the pelvis. It is therefore rare for a fibroid to obstruct labour.

2. *Changes in the fibroids.* Pregnancy causes several pathological changes in fibroids, the commonest being increase in size, œdema, necrobiosis, and torsion of the pedicle of a pedunculated subserous fibromyoma.

(*a*) *Increase in size and œdema.* There is hypertrophy of the muscle fibres of the tumour as in the rest of the uterus, and there is also œdema due to increased vascularity, so that the fibroids become larger and softer, and may be flattened out and also separated from each other by growth of the uterus.

(b) *Necrobiosis* (red degeneration) is particularly liable to occur during pregnancy. It is due to rapid degeneration and partial necrosis of the tumour, associated with damage to and thrombosis of blood-vessels. The cut surface of the tumour has a reddish-purple tinge and a faint odour resembling that of stale fish.

The symptoms and signs, which may be severe, are general and local. The general symptoms are a rise in temperature, a rise in the pulse-rate, malaise and occasionally nausea or even vomiting. The patient complains of lower abdominal pain which is sometimes of considerable severity. The degenerating tumour is tender and slightly, although scarcely appreciably, larger and softer than it was before the onset of necrobiosis.

(c) *Torsion of the pedicle* of a pedunculated subserous fibromyoma very occasionally occurs.

Effects of fibromyomata on pregnancy, labour and the puerperium

Pregnancy. Miscarriage is sometimes caused by fibromyomata, although it is difficult to be sure that any particular miscarriage is due to this cause. It is most likely to occur when the situation of the tumour is submucous, least likely when only a single subserous and pedunculated fibromyoma is present.

A fibroyoma, particularly if situated in the posterior uterine wall, may cause retroversion of the gravid uterus; occasionally incarceration with retention of urine results.

Labour. The first stage of labour. Fibromyomata, by interfering with the engagement of the head in the pelvis, may be responsible for malpresentations. It has been stated that fibroids will interfere with uterine contractions and therefore cause the first stage of labour to be prolonged; in fact this rarely occurs, the majority of cases have a normal first stage.

The second stage of labour. Delivery may be obstructed by a fibromyoma which is situated in the pelvis. This is unusual because most fibroids, except those arising from the cervix, rise into the abdomen during pregnancy or even in the early stages of labour.

The third stage of labour may be complicated by postpartum hæmorrhage, especially with submucous tumours; and particularly if the placental site covers the surface of a submucous tumour.

The puerperium. The chief puerperal complication is infection of a submucous fibromyoma: torsion of the pedicle may occur with pedunculated subserous growths; and the extrusion of a polypoid submucous fibroid has been recorded.

Regression of a fibroid may occur after delivery as part of the general involution of the uterus, providing that there are adequate blood-vessels reaching the tumour.

DIAGNOSIS

Fibromyomata which are projecting and nodular are easily felt in the wall of the pregnant uterus, and are distinguished from fœtal parts by their fixed position. Fibromyomata may, however, be very difficult to detect when they have become softened and flattened in the uterine wall, but fortunately in this case the tumours are very unlikely to interfere seriously with pregnancy or labour.

If a woman who is known to have a fibromyomatous uterus becomes pregnant the signs and symptoms of pregnancy are sometimes masked, or confusion may arise about the expected date of delivery as the uterus is larger than expected for the period of amenorrhœa. Intermittent hæmorrhages due to threatened abortion may be mistaken for menstrual bleeding. The tumours may make the swelling feel unlike the normal pregnant uterus in shape or consistence, or may make it difficult to feel fœtal parts. In cases of doubt a biological or immunological test for pregnancy should be carried out.

There are certain conditions which may simulate uterine fibromyomata associated with pregnancy. In early pregnancy the uterus may sometimes feel slightly irregular in form. In such cases the physical signs will be found to have altered at a second examination. A similar mistake may be made when there is an angular gestation, in which the ovum has become implanted close to the junction of one of the Fallopian tubes and uterus; or when there is a double uterus one half of which contains the fœtus.

The differential diagnosis between a large symmetrical interstitial fibromyoma and the pregnant uterus may be very difficult, especially when there is amenorrhœa due to the onset of the menopause or other intercurrent condition. Especially suggestive of pregnancy are marked softening of the cervix, or contractions and relaxations in the uterus. After the 7th week the biological or immunological pregnancy tests will be useful. Cases of carneous mole, in which the biological tests may be negative will give rise to difficulty. Repeated examination will reveal the presence of a living fœtus, by the rapid growth of the uterus.

TREATMENT

Pregnancy. Most women with fibromyomata pass through pregnancy without difficulty or serious symptoms. An expectant line of treatment is, therefore, the wisest. The pregnancy should be carefully supervised and a watch kept for untoward symptoms.

Threatened miscarriage, should be treated on orthodox lines (see p. 235).

Necrobiosis sometimes causes pain which is severe enough to require admission to hospital. The pain and other symptoms almost invariably subside within a week or 10 days in bed and the administration of morphia and

other analgesic drugs. Laparotomy is occasionally necessary if the diagnosis is in doubt, but is not an indication for myomectomy during pregnancy. Indeed, there are four good reasons for avoiding this operation. First, patients with fibromyomata are relatively infertile and operation is frequently followed by miscarriage and involves risking the patient's only opportunity of motherhood. Secondly, although the abdomen is opened with the intention of performing myomectomy, the local conditions may be such as to demand hysterectomy. Thirdly, the morbidity and mortality risks of myomectomy are undoubtedly increased by the co-existence of pregnancy. The fibromyomata afe less easily removed because the plane of cleavage between the tumours and their capsules is less well defined; while hæmorrhage is more profuse and often exceedingly difficult to control.

`·` *Torsion of the pedicle* of a pedunculated subserous fibromyoma and *incarceration* of a retroverted uterus containing a fibromyoma, which cannot be replaced after catheterizing the bladder, are two extremely rare complications for which laparotomy is indicated. It is also indicated in the even more unusual cases of *torsion of the pregnant uterus* and *intraperitoneal hæmorrhage*, due to rupture of a vein on the surface of a large fibromyoma. But all these four complications are pathological rarities which may not be seen during the life of many gynæcologists.

Labour. All pregnant women with fibromyomata should be confined in hospital. Towards the end of pregnancy, usually about the 36th week the important decision as to the the method of delivery will have to be made; first, whether it is to be vaginal or abdominal; and, secondly, if abdominal, whether hysterectomy or myomectomy should be combined with the Cæsarean operation.

Positive indication for Cæsarean section. In cases in which a fibromyoma is situated in the pelvis and offers obstruction to vaginal delivery Cæsarean section is imperative and should be performed shortly before term. Such cases are uncommon because, as has already been pointed out, nearly all fibromyomata rise into the abdomen during pregnancy or occasionally even in the early stage of labour.

General considerations. In the other cases, which form the large majority, it is difficult to specify which patient should be allowed to deliver herself normally and which should be treated by Cæsarean section. Natural delivery would be chosen in the case of a single small fibromyoma situated in the upper uterine segment; whereas in the case with a large number of tumours Cæsarean section with hysterectomy would be the practice of most gynæcologists. But the majority of cases lie between these two extremes and each must be judged on its own merits. There are, however, certain considerations which should be borne in mind when making a decision on this important question.

First, it must be remembered that labour is often uncomplicated. In

cases of doubt the sensible course to pursue is to allow labour to begin normally, being ready to interfere by Cæsarean section in cases of uterine inertia during the first stage; or by the application of the forceps when the second stage is delayed.

Secondly, failure of the head to engage before the onset of labour in a primigravida, or a malpresentation, would weigh the scales heavily in favour of Cæsarean section.
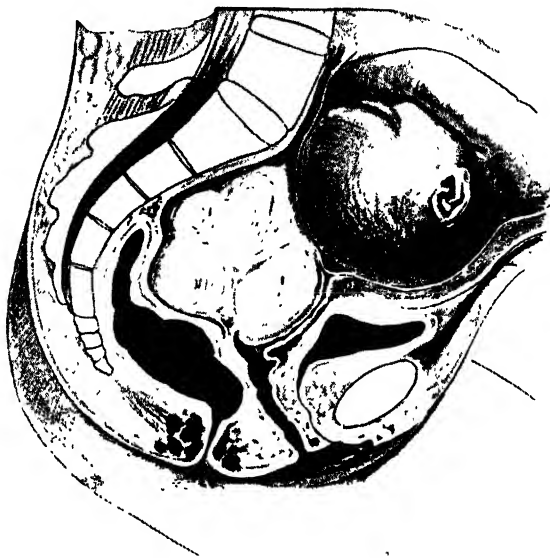
FIG. 184.   Fibroid tumour of the cervix which proved an insuperable bar to delivery by the natural passages.

Thirdly, the age and parity of the patient have an important bearing on the question. So often the pregnancy is the first at an age when the prospects of future child-bearing are steadily diminishing. Moreover many of these patients have been married for many years before the present pregnancy.

Fourthly, the larger the number and the greater the size of the tumours, the stronger is the indication for abdominal delivery.

Cæsarean section with hysterectomy or myomectomy. If the decision reached is to deliver the child *per abdomen*, should the fibroids be dealt with at the same operation and if so by myomectomy or by hysterectomy? Cæsarean section with myomectomy is a procedure to be avoided, because it is fraught with very considerable risk owing to the torrential hæmorrhage

which takes place from the cavities left after the enucleation of the fibro-myomata; even after apparently complete closure and obliteration by mattress sutures hæmorrhage often continues from the stitch holes and suture line. In theory it should be possible to arrest the bleeding; in prac-tice it is frequently impossible.

Myomectomy immediately after Cæsarean section is advisable only in the case of a pedunculated tumour, and when the fibroids are of insignificant size, or few in number. The operation of Cæsarean section with myomec-tomy should be considered hazardous. In those cases in which operative delivery has been decided upon but which are unsuitable for myomectomy there are only two alternatives: either to deliver the child by Cæsarean section, leaving the fibroids to be deal with later, or to remove the uterus with its tumours. The most sensible course is to remove the uterus in those cases in which myomectomy would be impossible at a later date, and to conserve it with its fibroids when there is a reasonable expectation of safely performing myomectomy after involution is complete and after an interval of at least 3 months.

OVARIAN TUMOURS

Incidence. Ovarian tumours are not commonly associated with preg-nancy, the incidence being somewhat less than 1 in 1,000 cases, about 0·1 per cent.

Type of tumour. The commonest ovarian tumours associated with preg-nancy are simple unilocular or multilocular cysts and dermoid cysts. Papillary cystadenomata, ovarian fibromata and endometriomata very occasionally occur. It is impossible to exclude the possibility that an ovarian cyst may be malignant; about 10 per cent of tumours in patients under the age of 30 are malignant and this proportion rises in patients who are older.

Effects of pregnancy on ovarian tumours. Torsion of the pedicle of an ovarian tumour occurs more often during pregnancy than at other times, and this accident is also common in the puerperium.

Rupture of the cyst, intracystic hæmorrhage, infection and necrosis can occur but are not any commoner among pregnant than among non-pregnant patients. Injury and necrosis may result from pressure on the tumour during labour. During the puerperium the pedicle is liable to become twisted owing to the rapid decrease in the size of the uterus; the laxity of the abdominal walls after delivery may be another factor pre-disposing to torsion. Infection and suppuration also occasionally occur.

Effects of ovarian tumours on pregnancy. Usually pregnancy con-tinues undisturbed by an ovarian tumour but miscarriage may occur owing

to interference with uterine growth. A pelvic tumour may prevent engagement of the fœtal head.

Labour will be obstructed by a tumour situated in the pelvis; obstruction is relatively more common than with fibromyomata which nearly always ascend into the abdomen before it begins.

DIAGNOSIS

The possibility that a tumour rising from the pelvis into the abdomen may be a full bladder must always be eliminated by catheterization.

In the early months of pregnancy the uterus is easily differentiated by bimanual examination from the rounded and probably movable pedunculated ovarian tumour lying behind and to one side of it, but occasionally there is difficulty. A valuable sign when it can be obtained is the periodical contraction and relaxation of the pregnant uterus.

The chief condition which will have to be distinguished from an intra-pelvic ovarian cyst associated with early pregnancy is retroversion of the gravid uterus. An ovarian tumour is usually displaced to the one side, is cystic and tense while the cervix points downwards; whereas the retro-flexed gravid uterus is central and soft and the cervix points forwards.

An ovarian tumour complicating pregnancy may occasionally be mistaken for an ectopic gestation, but this does not matter since laparotomy is the correct treatment in either case. The combination of a twisted ovarian cyst lying in the pouch of Douglas with a threatened abortion may be very difficult to distinguish from a tubal abortion. In all cases of doubtful diagnosis, in which there is any question as to the correct treatment to pursue, a careful examination should be made under anæsthesia.

In the later months of pregnancy, if an ovarian tumour lies in the pelvic cavity it will usually be discovered when an examination is made to investigate the reason for non-engagement of the fœtal head. If an X-ray examination is made it may reveal a dermoid cyst if it contains teeth or calcified areas. Care should be taken to exclude tumours arising from the pelvic colon.

If the tumour is adherent to the uterus, twin pregnancy, myoma, bicornute uterus, or even hydramnios may be simulated, and here again it may be necessary to make a careful examination under anæsthesia.

TREATMENT

An ovarian tumour should be removed as soon as it is diagnosed whether the patient is pregnant or not, except during the first 12 weeks of pregnancy, because it may be malignant or it may become malignant. Moreover while the tumour remains in the peritoneal cavity it is subject to the

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risks of torsion of the pedicle, rupture, intracystic hæmorrhage and other secondary changes.

When pregnancy co-exists an ovarian tumour should always be removed if diagnosed during the first half of gestation, for the reason that the tumour is potentially malignant. It has been said that removal of the corpus luteum before the placenta is fully developed will cause a miscarriage and, although there is some doubt about the truth of this statement, it is wise to wait until after the 14th week before operating.

Every effort should be made to conserve ovarian tissue if the tumour proves to be innocent. The cyst or tumour is enucleated from the rest of the ovary.

When the diagnosis is not made until late in the pregnancy, either Cæsarean section with removal of the ovarian cyst should be carried out shortly before term; or natural delivery should be allowed to occur at term and the cyst removed during the puerperium. With an intrapelvic tumour which will obstruct delivery the former method should be selected; in those in which it is not offering obstruction the latter is the treatment of choice.

CARCINOMA OF THE CERVIX UTERI

Cancer of the cervix is a very rare complication of pregnancy, labour and the puerperium. It is found almost exclusively in parous women and is a very dangerous complication. The comparative rarity of the complication is due to the fact that the disease usually occurs in the later years of menstrual life when pregnancy is less likely to occur. The vaginal discharge that accompanies the disease in its later stages, doubtless tends to prevent conception, but in the early stages there is little influence of this kind.

DIAGNOSIS

Whenever a woman who is pregnant has irregular hæmorrhage, or a purulent or fœtid vaginal discharge, she should be examined *per vaginam*, since the cause may be carcinoma of the cervix. The diagnosis is made by the usual methods. A cervical smear is taken if this has not already been done as a routine examination. Close attention should be paid to any friable tissue in the cervix of a woman advanced in pregnancy lest an early case of carcinoma of the cervix should be missed. When there is any doubt as to the diagnosis, a small piece of the friable tissue should be removed for examination under the microscope. Abortion does not necessarily follow this procedure.

When the growth is endocervical the diagnosis in early cases is not so easy, since intermittent hæmorrhages will be the only clue to the diagnosis and confusion may arise between endocervical cancer and antepartum hæmorrhage, that is to say hæmorrhage from the placental site.

TREATMENT

If the growth is in an early stage immediate Wertheim's hysterectomy is the best treatment. In the early weeks of pregnancy this can be performed without emptying the uterus, but in other cases hysterotomy or Cæsarean section would be the first step of the operation. Some surgeons would prefer to treat such early cases with radium, but the uterus would first have to be emptied by hysterotomy or Cæsarean section, and delay would be inevitable before the radium could be inserted.

In cases in which the growth is so advanced that radical operation is impossible the uterus should be emptied by hysterotomy or Cæsarean section, so that treatment with radium and X-rays can be given. Delay in treatment in the fœtal interest would only be justifiable in an advanced case in which the maternal prognosis was already very bad.

The dangers of allowing natural labour to take place are severe hæmorrhage, rupture of the uterus, and puerperal sepsis.

THE RELIEF OF PAIN IN LABOUR

THE amount of pain experienced in labour varies enormously from patient to patient. Some women find that labour is almost painless, whilst others complain of unendurable agony. Some, therefore, will need minimal doses of analgesic drugs and others demand much more. The degree of pain appears to have no direct relation to the strength of the uterine contractions or to the mechanical difficulties of the case. With many patients the first stage of labour is more painful than the second, and labour in cases of abnormal uterine action especially tends to be painful.

In many cases the pain of parturition is due to fear and ignorance. The Victorian tradition—well based in its day—of difficult, agonizing and often fatal child-bearing, has influenced our folklore. Fear and apprehension about the outcome of labour are latent or frankly obvious in the majority of primigravid patients and in some multiparous patients who have had unfortunate experiences.

The antenatal patient is frequently disturbed by gossip in waiting rooms where horrific stories and experiences are often recounted. Elderly relatives who are long past their child-bearing frequently take delight in telling tales of agony and disaster. In the lives of most women child-bearing is the most important episode and many of these tend to dramatize their experiences. The old campaigner who recounts vivid stories of battles is not always the winner of medals! And there are some women who could vie with Baron von Münchhausen.

In country districts this fear-making propaganda seems to be most potent and an interesting collection of old wives' tales can be made. Such fear-making sources of information can be counteracted by the discerning physician who will, at the same time, increase his knowledge of the popular prevailing misconceptions. To try and laugh off the old wives' tales is the worst thing to do. They must be taken seriously for they are serious to the patient, but given confidence she can be educated into a happy frame of mind. From patients who have been delivered and whose confidence has been obtained much valuable information can be obtained as to their problems and what helped or failed to help them. It must be remembered that antenatal care is the product of the present century. Before that the antenatal patient gleaned her information about labour from older women and from friends who had had babies. It is probably true to say that the antenatal patient of today is more enlightened than her mother and this is one reason why labour has fewer terrors now than formerly.

The most important factor which will help the patient during the

antenatal period and labour is having a doctor or midwife in whom complete and quiet confidence can be placed. A person who is sympathetic can answer all problems simply and, more important, divine underlying thoughts and worries and so help the patient to unburden herself. This is largely a question of temperamental compatibility. To overcome a back-ground of fear it is necessary first to change the patient's mental approach to labour. The practice of referring to uterine contractions as pains unfortunately perpetuates this fear. The doctor should think, and attempt to teach his patients to think, in terms of what is now called the psycho-somatic approach. The influence of the cerebral cortex on the nervous sys-tem and the effect of cortical excitation and inhibition should be explained in simple terms. The patient can readily be made to understand that suggestion can both cause and prevent pain. She will understand that nervous tension can produce physical tension and that this physical tension may result in inco-ordinate and obstructive muscular contraction. The realization of this will allow her to accept the idea that a relaxed mind and a relaxed body will make labour easy.

It is important for the patient to have some understanding of the anatomy, physiology and mechanism of labour. Many patients do not understand that the first stage of labour is long in relation to the second and that it is devoted only to the opening up of the birth-canal and not, therefore, rewarded by a sensation of foetal descent. This leads to a fear that labour is not progressing normally, to a feeling of frustration and so to the development of uterine inertia. At the back of every woman's mind is a natural fear of obstructed labour or, as she probably thinks of it, a doubt that so large an object as a baby can come through so small an organ as the vagina. Explanation of the mechanism of labour in simple terms will do much to overcome these fears. The patient should be taught how to use relaxation and correct breathing in the first stage of labour and so allow the contractions to pass without her attempting to take an active part by bearing down. She should be taught to use the contractions of the second stage employing the respiratory rhythm: breathe in—breathe out—breathe in—hold your breath—push . . . until she is told to change to a slow, deep-breathing rhythm during the birth of the head.

Doctors and nurses at antenatal clinics should be especially careful not to make indiscreet, disturbing or confusing remarks. The aim and object of antenatal care is to remove all removable fears and worries from the patient. This includes imparting such information as will make pregnancy a happy experience, and the birth not an unknown nightmare but a new experience about which she is fully briefed. It is obvious that unnecessary discussions in the presence of the patient about correctness of dates, the position of the child, engagement of the head, the level of the blood-pressure or any other factor which could be constructed by the patient

as meaning 'something is wrong' must be avoided. If such discussions are necessary for teaching purposes then that fact must be pointed out to the patient and she must be told that she is quite normal, if that is the case. The discussion otherwise should be held out of earshot of the patient. All this is very obvious but not always remembered. In particular, pupils and other inexperienced attendants should be most guarded in their remarks and in the way they examine patients.

During labour any fear or apprehension becomes maximal and what has been said about the conduct of attendants during antenatal visits becomes increasingly important during labour.

Patients after delivery will often say that the most reassuring factor is the knowledge that her chosen antenatal attendant is close at hand when wanted or present the whole time, to give assurance, answer questions and order analgesic drugs if and when required. Care should be taken by the attendants not to leave the patient alone in a closed room or to allow her to overhear and possibly misconstrue their medical remarks, conversations and discussions of abnormalities of labour. In an abnormal labour the patient's emotional reaction must be carefully studied; any sign of anxiety or failing confidence must be countered by a clear-cut programme and a worried or puzzled look must be avoided in her presence. The importance of these generalizations can be learnt from the experiences of multiparous patients. From all this it is obvious that the ideal arrangement would be for every pregnant woman to have attendants in whom she has complete confidence and who will attend her throughout pregnancy and labour. With the vast majority of women this is impossible. An attempt is made to bridge the gap and solve the problem by inviting the antenatal patients to attend lectures and demonstrations organized by the antenatal department. These antenatal classes, which should be given by the midwives and physiotherapist attached to the department, will dispel the fear of the unknown by explaining what will happen in pregnancy and labour. The pregnant woman is highly susceptible to suggestion, and the normal rather than the abnormal should be stressed, with the idea of transforming an ordeal into a wonderful experience. Labour is very rarely painless, and the patient should be told that drugs are at hand to help her if they are necessary. The physical training for labour is centred on relaxation of muscle tension, which also requires mental relaxation. This is greatly helped by practising the controlled relaxation required in the first stage, and by understanding the effort of pushing required in the second stage. It may be assisted by teaching the patient to concentrate on regular respiratory movements during each contraction.

The patient should also receive instruction in the use of the analgesic apparatus which will be available. She should not use apparatus in labour without previous training.

The use of analgesics and anæsthetics in labour

The requirements of an ideal analgesic agent are:

1. It should not harm or endanger the life of the mother or affect her co-operation.
2. It should not decrease uterine contractions.
3. It should not occasion more frequent operative intervention.
4. It should not harm the baby by interfering with the establishment of respiration at birth.
5. It should be easy to administer and be foolproof.
6. It should have uniformly successful results.

As no such agent has yet been discovered a wide variety of drugs is in use and practice varies from hospital to hospital.

In the first stage of labour

Potassium bromide, chloral hydrate, tincture of opium. These drugs are less often used than formerly. It was formerly routine practice to prescribe a mixture containing potassium bromide, chloral and tincture of opium early in labour. Such a mixture is not very effective and sometimes causes vomiting.

Barbiturates. These drugs have been known since 1903 but only during about the last two decades have they been used in obstetrics. Essentially they are hypnotic drugs and only analgesic in anæsthetic doses. Pharmacologically they all have a similar action but are grouped according to their speed of action. The long-acting group was first discovered. Phenobarbitone is an example; its action is too slow for use in labour although it is employed antenatally and during the puerperium, particularly in the presence of pre-eclamptic toxæmia. The ultra short-acting group is widely used in anæsthesia, thiopentone and hexobarbitone being examples.

Pentobarbitone (Nembutal) and quinalbarbitone (Seconal), short-acting barbiturates, and sodium amytal, a medium-acting barbiturate, are all used during labour. These drugs given in a dosage of 200 mg. (gr. 3) are most valuable as hypnotics for a patient in whom labour is not properly established. Their value in well-established labour is dubious. Absorption from the intestine may be erratic in established labour and the respiratory centre of the newborn baby may be depressed, because the barbiturates pass the placental barrier. Restlessness and excitement with loss of control may occur. For these reasons the barbiturates seem to have little place in domiciliary midwifery.

Pethidine. This is also known as Demerol, Dolantin and Meperidine. It is a synthetic drug discovered in 1939. Pharmacologically it is an analgesic having about a tenth of the effect of morphine on pain. It has an antispasmodic effect on smooth muscle, a papaverine-like action, and an

atropine-like effect on nerve endings, depressing cholinergic nerve supply to smooth muscle. Sedative effects are less marked than with morphine, and rarely the patient may become apprehensive. Although it was claimed that pethidine had no depressant effect on the baby's respiration, this is not the case, and there is a variable depressant effect on the respiratory centre. The usual dose is 150 to 200 mg. by intramuscular injection, which may be repeated in 2 hours. A total dose of 300 to 400 mg. is commonly employed though in some hospitals much larger doses are given.

It should be remembered that pethidine is a habit-forming drug and that it comes under the *Dangerous Drugs Act*. However, midwives acting alone are allowed to administer the drug, the total dosage being controlled. Pethidine is at present widely employed for obstetric analgesia. It is sometimes combined with phenergan 25 to 50 mg., promazine (Sparine) 25 to 50 mg. or sometimes hyoscine hydrobromide, 0·4 mg. (gr. 1/150) to increase the sedative effect.

Morphia. This valuable analgesic is not used so frequently as it might be, particularly during a prolonged first stage. Formerly it was the practice to give morphia 15 mg. (gr. ¼) to nearly every primigravida, when the cervix was 2 or 3 fingers dilated. There is a widely held view that morphia is responsible for marked respiratory depression in the baby. Certainly if the morphia is given within 4 hours of delivery, then respiratory depression is attributable to morphia. However, respiratory depressive effects from morphia, Omnopon or pethidine can now be neutralized by the use of a new drug, nalorphine hydrobromide (Lethidrone). This drug was first prepared in 1941 and was found to antagonize the respiratory depression produced by morphine. Administered by itself nalorphine acts as a depressant of respiration and circulation. Nalorphine does not counteract respiratory depression produced by barbiturates, cyclopropane, ether or any drug not chemically related to morphine.

Dramatically good results have been obtained by injecting 1 mg. of nalorphrine hydrobromide into the umbilical vein of the new-born child. One milligram is issued as a solution in a 2 ml. ampoule. This drug may also be administered to the mother by giving 10 mg. intravenously 5 minutes before the birth of the child.

Morphine sulphate 15 mg. (gr. ¼) combined with hyoscine hydrobromide 0·6 mg. (gr. 1/100) is of the greatest value in securing sleep during an abnormally long first stage.

Omnopon 20 mg. (gr. ⅓) combined with hyoscine 0·4 mg. (gr. 1/150) is a less powerful combination indicated in similar circumstances.

Paraldehyde is a safe and effective basal narcotic and is only slightly depressant to the fœtal respiration. The main objection is its smell. It can be administered per rectum. Paraldehyde 15 ml. (½ fl. oz.) is shaken up in 60 ml. (2 fl. oz.) of olive oil or saline. A catheter is introduced into the

rectum and pushed up above the presenting part and the paraldehyde then run in. More conveniently 5 to 10 ml. supplied in ampoules, can be given intramuscularly. Paraldehyde is not often used in normal labour but it is a safe drug which may be useful for patients who are nervous and difficult to control in the first stage of labour. It is frequently used in the treatment of eclampsia.

In the second stage of labour

Nitrous oxide and air, commonly referred to as 'Gas and Air'. This is self-administered by means of a Minnitt's or similar apparatus. Midwives are permitted to supervise its use, provided they hold a certificate of training in its use and that the patient has been examined by a doctor and has been certified as fit for such an administration. Originally the machine delivered 35 per cent of nitrous oxide with 65 per cent of air. As this was not always sufficiently potent the proportions were changed to equal parts of nitrous oxide and air. As only a fifth part of air is oxygen this mixture allows 10 per cent of oxygen in the inhaled mixture. This would induce anoxia if administered continuously and therefore only intermittent use is permissible, and this method should not be used for cases of maternal cardiac disease or of fœtal distress. This oxygen content is the limiting factor and unfortunately for some patients 50 per cent of nitrous oxide is insufficient to produce analgesia. There have been modifications of the machine, either to deliver pure nitrous oxide for one or two breaths, then the usual gas-air mixture, or to deliver nitrous oxide and oxygen, but none have been generally accepted as satisfactory. Not infrequently if one of these machines is tested it will be found that the mixture delivered differs from that stated, and the mixture may vary with different degrees of respiratory effort.

It must be emphasized that the percentage of successes with gas-air analgesia will be greatly increased if the patients are shown the apparatus before the expected date of confinement, and not for the first time when they are actually in labour. They should be instructed in its use and shown how to apply the mask firmly to the face and how to close the safety air intake with the finger. They must know that in order to gain full benefit they must start to use the machine as soon as a contraction is felt to be commencing and not when it has become established. During labour it must be ascertained that patients have remembered all these points. If necessary there must be repeated explanation of the machine's use.

Nitrous oxide and oxygen. The mixture must consist of not less than 20 per cent of oxygen if anoxia is to be avoided. To ensure that the proportions are correct an accurate machine is required, fitted with flow meters. Many types of machine have been devised. The common Boyle's machine is a continuous-flow apparatus. This means that when the gases are turned

on they flow continuously from the face-piece. The Walton and McKesson machines are of intermittent flow type in which the gases leave the facepiece only when the patient inspires through it. These pieces of apparatus must be under the control of an anæsthetist, when general analgesia or light anæsthesia can be induced at will. Recently a machine (Lucy Baldwin) has been devised for the self-administration of nitrous oxide and oxygen.

Chloroform. This was first used to induce anæsthesia by James Young Simpson in Edinburgh in 1847. Formerly it was in common use and had the advantage of being easily administered and absorbed. It reduces the strength of uterine contractions and, unhappily also, there have been many fatalities when it has been used unskilfully. The prolonged or repeated use of chloroform, even in minimal concentration, may cause fatal delayed chloroform poisoning. Its use is especially to be condemned in cases in which the liver may already be damaged, as in toxæmia of pregnancy. Its portability, low volatility and non-inflammable character still give it a place in emergencies in domiciliary midwifery when other methods are not available, or in the tropics.

air inlet closed by finger

filler

trilene vapour outlet

bed clamp

(British Oxygen Company)

FIG. 185.   Freedman's inhaler.

Trichlorethylene (Trilene). This chemical has been known since 1864 and has been used in industry as a fat solvent. Its analgesic properties have been known since 1915. It was first used as a general anæsthetic agent in 1935. It is a colourless liquid with an odour resembling chloroform. It is non-explosive. It is stored in amber glass bottles, because it decomposes in sunlight. Soda lime also causes it to decompose; therefore it must never be used in a closed circuit anæsthetic machine. It is issued as the proprietary preparation 'Trilene' which is coloured blue for identification purposes

with waxoline blue. Pharmacologically it resembles chloroform in its effects but has a less depressant action on the heart and circulation. In excessive dosage it depresses respiration. Most of the drug is excreted unchanged through the lungs. In obstetrics 0·5 to 0·65 per cent trichlorethylene in air is delivered to the patient. Many pieces of apparatus have been devised to allow the self-administration of the mixture. The Freedman inhaler is a simple apparatus which cannot be overfilled, can be clamped to the bed and delivers approximately 0·65 per cent trilene in air by a simple draw-over procedure. When it is given with this machine trichlorethylene produces satisfactory analgesia in most patients without decreasing the strength of the contractions or affecting the baby. Unfortunately it was found to be unsafe for use by the unsupervised midwife, because the strength of vapour varied greatly with the temperature and the rate and depth of respiration, or if the bottle was shaken. The Emotril and Tecota machines have been approved for use by midwives, and deliver a vapour containing 0·5 per cent by volume of trilene, with a permissible variation of 0·4 to 0·6 per cent.

Anæsthesia for operative deliveries

For operative deliveries, whether abdominal or vaginal, a number of methods of anæsthesia and agents are available. Certain basic considerations must be observed. Firstly, the agents used must not depress the baby's respiration at birth, so morphia and allied drugs must not be given as premedication. Secondly, the lower segment operation for Cæsarean section (now a routine) needs a deeper relaxation during the preliminary dissection and probably calls for a longer time between induction of anæsthesia and delivery of the baby. Luckily its increasing popularity has coincided with the introduction of muscle-relaxant drugs and the practical difficulties of the anæsthetist are now lessened. The circumstances of the delivery and the skill of the attendants determine the choice of anæsthetic.

General Anæsthesia is frequently employed.

Nitrous oxide, oxygen and ether or trilene are commonly used when apparatus is available. The use of pentothal, cyclopropane and oxygen, halothane (Fluothane) or relaxants is left to the decision of the skilled anæsthetist. If relaxants are used a cuffed intratracheal tube should be employed.

Open ether using a 'rag and bottle' technique still has its place when anæsthetic apparatus is not available. Induction can be effected by a chloroform-ether mixture (C2:E3) or by ethyl chloride.

A number of fatalities occurs every year from complications of general anæsthesia, and these account for 3·6 per cent of maternal deaths. Most of

these accidents are due to inhalation of vomit, when solid particles obstruct the bronchioles, and acid gastric fluid will cause intense bronchiolar spasm (Mendelson's syndrome). The patient in labour usually has gastric stasis and during light anæsthesia vomiting readily occurs.

Prevention. Solid food should be withheld during labour, and also fluids if delivery is likely to be within four hours. If there is no means of lowering the head of the bed the patient may be anæsthetized and delivered in the left lateral position. All labour ward beds should be constructed so that the head can be lowered quickly.   .,

Treatment. Should vomiting occur the head of the patient must be lowered at once and turned on one side, so that the vomit can flow out of the mouth rather than down the trachea. Suction apparatus must be instantly available to clear the nasopharynx.

Respiration should be carefully observed following vomiting during anæsthesia lest there should be collapse of the lungs.

Regional analgesia. In many hospitals this is preferred to general anæsthesia.

As an alternative to inhalation anæsthesia regional or local anæsthesia offers the following advantages:
1. It does not affect the baby.
2. It does not affect the uterine contractions.
3. It does not carry the risks involved when vomiting occurs during anæsthesia.
4. It can be used by a single-handed obstetrician when no anæsthetist is available.
5. It encourages gentleness during obstetric vaginal operations.

Obviously no method of relieving pain can be absolutely safe and the risks involved in the use of local anæsthetics are overdosage, individual idiosyncracy and accidental intravenous injection.

Not all patients are temperamentally suited to this type of analgesia, and it is now common practice to give apprehensive patients a sedative to induce narcosis, such as a slow intravenous injection of pethidine 100 mg. with chlorpromazine 12·5 mg., before using one of these methods.

Three methods may be used for vaginal delivery:
1. Epidural and caudal analgesia.
2. Paracervical block.
3. Pudendal block and perineal infiltration.
Cæsarean section can also be performed after local infiltration of the abdominal wall.

For all these techniques lignocaine (xylocaine) may be used in 1 or 0·5 per cent solution. The addition of adrenalin is not necessary because the

duration of action of lignocaine is sufficient for the obstetric operations for which it is employed. Hyaluronidase added to the anæsthetic solution appears to have no special advantage and is more likely to reduce the duration of action by speeding the rate of absorption.

It should always be remembered that there is a maximal dose of local anæsthetic drugs which may be injected. For lignocaine this is 0·5 g., or 50 ml., of a 1 per cent solution, or 100 ml. of a $\frac{1}{2}$ per cent solution. These quantities must not be exceeded, so the volume at various sites of injection should be planned in advance.

1. *Epidural and caudal analgesia.* Epidural analgesia has now taken the place of spinal analgesia in this country. The anæsthetic is injected into the epidural space through a Tuohy needle which is usually inserted between the first and second lumbar spines. One per cent xylocaine is used. If the analgesia is to be continued a polythene catheter is threaded through the needle and left in the epidural space so that further injections of xylocaine can be given.

Epidural anæsthesia may be used for difficult vaginal delivery or for Cæsarean section, and occasionally when labour is unduly prolonged or painful, especially in cases of hypertonic inco-ordinate uterine action. The pain of contractions is completely removed.

In caudal analgesia a malleable needle is inserted through the sacral hiatus so that the tip lies in the extradural space. For continuous analgesia a polythene catheter can be left in position. This method may be used for vaginal deliveries. Uterine contractions are unaffected, except that the patient has no pain, but the voluntary expulsive efforts in the second stage are poor, and the delivery has usually to be assisted with forceps. The baby is unaffected and blood loss is minimal. Against these advantages must be weighed the difficulty in inserting the needle, the need for constant supervision by personnel trained in the use of this method, and the increased forceps-rate. It is obvious that the method is unsuitable for domiciliary obstetrics.

2. *Paracervical analgesia.* Lignocaine may be injected into the paracervical tissues by inserting a needle through the lateral vaginal fornix on each side. This will block the paracervical nerve plexuses and relieve the pain due to stretching and dilatation of the cervix. The effect only lasts for about an hour but it is possible to use needles attached to plastic catheters, which may be left in place so that further injections can be given.

3. *Pudendal block and perineal infiltration.* This simple technique can be used for:
1. Normal (spontaneous) delivery.
2. Repair of perineal laceration and episiotomy.
3. Low forceps delivery.

4. Assisted breech delivery.

5. Some cases of mid-forceps delivery and manual rotation of the head.

6. In twin labour if the patient is able to remain conscious during opera-
tive delivery of the first twin, then if the second presents by the breech,
the mother will be able to make expulsive efforts and diminish the risk
of breech extraction (or of waiting for consciousness to be recovered).

The pudendal nerve is derived from the 2nd, 3rd and 4th sacral nerves.
These branches usually unite just above the ischial spine. The nerve passes
out of the greater sciatic foramen posterior to the ischial spine and enters
the lesser sciatic foramen. It then 'enters the pudendal canal; the vessels lie
lateral to the nerve.

FIG. 186.   Showing the method by which the index finger of the left hand in the
vagina is used to direct the point of the needle to its correct position in relation to
the ischial spine.

The nerve divides into:

1. The inferior hæmorrhoidal nerve giving branches to the rectum,
internal anal sphincter and the skin around the anus.

2. The perineal nerve, the largest branch, supplying the skin of the
perineum, labia majora and the muscles of the superficial and deep perineal
groups.

3. The dorsal nerve of the clitoris supplying the clitoris and labia minora.

Sometimes fibres from the posterior femoral cutaneous nerve and the
ilio-inguinal nerve also supply the perineum.

Technique. Using 1 per cent lignocaine a skin weal is raised halfway between the anus and ischial tuberosity. The index finger of the left hand is inserted into the vagina and the ischial spine palpated (the ischial spine may also be located by rectal examination). A 20 cm. 20 gauge needle is used for the block, being passed through the skin weal and directed towards the ischial spine. The tip of the needle is palpated by the finger in the vagina and its relation to the ischial spine determined. The needle is pushed just posterior to the inferior tip of the spine. The plunger of the syringe (preferably Labat's type) is withdrawn to prevent injection into a vessel and then the injection is made. The needle is inserted a further centimetre and more lignocaine injected following withdrawal of the plunger to test for intravasation. A total of 10 ml. of 1 per cent lignocaine is used.

The process is repeated on the opposite side.

Pudendal block is usually combined with local infiltration of the vulva, a weal being raised at the fourchette and 0·5 per cent lignocaine infiltrated freely here and on each side extending well forward in both labia majora. If the local infiltration is carried out before the pudendal block it will reduce the discomfort of the manipulations required for the block itself.

The anæsthetic will take effect within 3 minutes. All vaginal manœuvres must be carried out with great gentleness. If used for forceps delivery the patient often experiences discomfort when the blades are applied. If she is encouraged to bear down whilst traction is made on the forceps it will often reduce discomfort considerably.

If the block is put in too soon in a breech delivery it may stop the patient's urge to bear down.

The problems of general anæsthesia for operative delivery are more fully discussed in special text-books to which reference should be made.

OBSTETRIC OPERATIONS
FOR VAGINAL DELIVERY

DELIVERY BY THE FORCEPS

THE original obstetric forceps was invented by one of the two elder
Chamberlen brothers who came of a Hugenot family settled in England
about the year 1600. The invention was kept secret in the Chamberlen family
for over 100 years and passed from the third Chamberlen brother, Peter,
down to his grandson Hugh with whom it remained and perished when
he died in 1728. For nearly another hundred years, until 1818, the forceps
with the rest of the Chamberlen instruments lay hidden beneath the floor-
boards of a box-room in Woodham Mortimer Hall, Essex, which had been
the Chamberlen's home for 80 years.

The Chamberlen forceps were only slightly modified during the hundred
years of their secret existence and consisted of two blades, curved to fit the
fœtal head, joining two short handles, the two halves being strapped to-
gether where they crossed because they had no lock. Not long after their
re-discovery, Chapman improved the forceps by introducing the shank
between the blades and handles and thereby lengthening the instrument.
In 1744 William Smellie devised the double slotted English lock which
allowed easy, accurate application and at the same time gave additional
strength.

The next step forward was in 1747 when the pelvic curve was introduced
by Levret of Paris.

The long curved forceps had now arrived but James Young Simpson
made important improvements in 1848. He increased the length of the
shanks which were made parallel beyond the lock (to prevent injuring
the vaginal introitus during traction) and increased the size of the blades
and their curve. Simpson advised a pelvic application of the forceps when
the head was oblique in the pelvis because he said there was more room and
injury to the mother less likely. This is now known to be wrong; the blades
should be accurately applied to the head. In 1877 axis traction rods were
added by Tarnier to improve the mechanics of traction in the high forceps
operation; Milne Murray's modification appeared in 1895. The high
forceps operation is now obsolete, so that axis traction rods are seldom
employed. Kielland's forceps were introduced by Christian Kielland in
1915. Their purpose is not only traction, but also rotation of the head.
Although they were devised so long ago, it has only been in comparatively

recent years that their value has been appreciated and their use at all common.

Finally, light short curved forceps were introduced by Wrigley in 1935, their particular purpose being the low or outlet forceps operation.

This description of the evolution of the forceps has kept strictly only to the important advances and makes no mention of the other very numerous types of forceps, differing in variable degree, in use to-day.

The object of the application of the forceps. The forceps is used to apply traction to the head of the fœtus in a pelvis of adequate size. When Kielland's forceps is used the head may first be rotated into a more favourable position before traction is applied.

Presentations suitable for forceps delivery. The forceps should be applied only to the head of the fœtus. They are designed to fit the head; if applied to the breech they are liable to slip with resulting injury to the fœtus and maternal soft parts.

The presentations suitable for the forceps operation are vertex, face with anterior chin, and the after-coming head of the breech. The vertex may have the occiput anterior or posterior, but when the latter is the case certain additional factors, referred to later, must be taken into account.

Indications for the use of the forceps

Before using the forceps there should always be a clear indication that good will come from their use and that the instrument is not merely being used for convenience to expedite delivery in a normal labour. The aim always should be to give *assistance* when it is needed, and whilst the circumstances vary considerably the particular indication in almost every case will be found to be one or more of the following, delay in the second stage of labour, impending or established maternal distress, impending or established fœtal distress. Occasionally aid may be indicated because the second stage contractions are beginning to wane—a sign of impending uterine exhaustion. It is important that a careful abdominal and vaginal examination should be made before applying forceps; usually under anæsthesia. The bladder must be emptied by catheter. Preparations for proceeding straightway to forceps delivery should have been made, but the importance of a thorough vaginal examination under anæsthesia cannot be too forcibly stressed, in order that the blades may be applied accurately and safely to the head.

Delay in the second stage of labour. The duration of the second stage varies with the efficiency of uterine action, and with the resistance to descent of the head. In primiparæ it lasts between 1 and 2 hours; but in

multiparæ it is very much shorter, usually being less than half an hour. A second stage, therefore, is commonly considered to be delayed if the limits mentioned are exceeded; but this definition is only a guide, it must not be too rigidly observed. Because the duration of labour depends on the strength of contractions, delay can be said to occur when progress is not in keeping with such contractions. If the contractions are normal the second stage is expected to be of normal duration. With very strong contractions delay is obvious much earlier. On the other hand when the contractions have been weak throughout labour, progress may be expected to be slower than normal and concern need not be felt as long as the presenting part is advancing and the patient and fœtus are not distressed. This is not to say that conservatism should be pushed to the limits of human endurance.

'Conditions likely to cause delay in the second stage of labour

    (i) Inadequate uterine contractions.
    (ii) Rigid pelvic floor and perineum.
    (iii) Large fœtus.
    (iv) Contraction of the pelvic outlet.
    (v) Persistent occipito-posterior position or deep transverse arrest of the head.
    (vi) Persistent mento-posterior position.
    (vii) Constriction ring.
    (viii) Extended after-coming head.

A common cause of delay in the second stage in first labours is the resistance of the pelvic floor, but it should be treated by episiotomy rather than by the application of the forceps.

Persistent occipito-posterior position of the head, when it has passed the obstetric outlet, often has the same effect because the wide bi-parietal diameter, now too far back, over-distends the perineum; in fact there is commonly so much rectal pressure that it looks as though the head is trying to be born *per anum*. If the head descends so low as this an extensive perineotomy is usually all that is needed but forceps may be required above this level.

The conditions so far mentioned cause delay at or below the pelvic outlet and call for the low or outlet forceps operation for which the short curved forceps is admirably suited.

The second stage may also fail to progress because the head is delayed in the pelvic cavity. At this level nothing of the head would be seen when the patient bears down, nor would the perineum have begun to distend. The plane in which the head is most commonly arrested is just above that which marks the junction of the cavity with the obstetric outlet, namely the narrow pelvic plane at the level of the ischial spines. The conditions which cause delay at this level are deep transverse arrest and persistent occipito-posterior position; less commonly it is due to a face presentation with

the chin posterior or obstetric outlet contraction. It is here too that arrest would occur when a constriction ring below the shoulders is present.

In order to diagnose the cause of delay in the pelvic cavity a careful examination should be made under anæsthesia, so that the whole hand can be used inside the vagina.

To apply forceps to the head when it occupies the pelvic cavity constitutes the mid-forceps operation. When the head is just above the level of the ischial spines it is called 'low mid-cavity' forceps and usually the long curved forceps, or Kielland's forceps, are used. With the head higher than this (but still within the cavity), as after manual rotation, it is spoken of as 'high mid-cavity' forceps delivery.

Axis traction forceps were originally designed for the high forceps operation with the head above or in the brim. The dangers of this operation make it unjustifiable now that Cæsarean section can be used so much more widely and safely; therefore it has been abandoned.

Maternal distress. Once the second stage is reached it is seldom justifiable to allow signs of distress in the patient to appear. When it occurs early it usually means that contractions are strong and arrest has already occurred; when late the safe limits of endurance have been passed. A patient in the second stage needs constant supervision, one of the reasons being to watch for signs of impending distress.

But distress may arise from causes other than purely obstetric, and in certain cases there may be every reason for wishing to avoid even the earliest signs of stress. In cases of heart disease and severe pulmonary disease the forceps should always be applied unless the second stage is progressing smoothly and quickly. In severe pre-eclampsia or eclampsia the stress of expulsive efforts should always be avoided.

When considering whether or not to use forceps under the conditions just mentioned, it is always profitable to compare the relative disadvantages of the effects of anæsthesia with those of a slightly longer second stage with spontaneous delivery. The decision is made much easier nowadays because of the availability of pudendal block analgesia.

Signs of established or impending maternal distress. These may be broadly divided into mental and physical, although the former will always be present in some degree when the latter have appeared. Mental distress occurs in patients who have had a long tedious first stage and are in no condition to co-operate in aiding expulsion during the second stage. In some cases the patient is moaning and apathetic; in others restless and uncooperative; there is always some element of confusion. Sometimes a primigravida will be mentally distressed in the second stage, even after a normal first stage, because she has been frightened and tense throughout. This commonly means that sedatives have been used too sparingly.

The signs of physical distress are a rising pulse-rate and a slightly raised temperature; but this is variable because sweating tends to control it. The blood-pressure always rises a little even in a normal second stage. But apart from the pulse chart the most striking signs are those of the patient's appearance. If labour has merely been long she will look tired and say so, but if distress has arisen as a result of obstructed labour the contractions are strong and the patient has an air of restless anxiety. Abdominal and vaginal examination will show signs already mentioned in Chapter 27.

Fœtal distress. The following conditions are likely to cause fœtal distress:

(i) Cord complications (prolapse, tight loop or knot).
' (ii) Placental insufficiency (toxæmia, hæmorrhage, postmaturity).
(iii) Prolonged or difficult labour.
(iv) Uterine infection.

Presentation and prolapse of the umbilical cord are mentioned first because the threat to the fœtus is so serious and emergency measures are needed so urgently. The subject is dealt with in Chapter 31 but under suitable conditions expeditious forceps delivery may be needed.

Signs that all is not well with the fœtus may develop in any labour but may be expected in particular circumstances. Anything that interferes with fœtal oxygenation will bring it about. Such conditions as placental infarction and accidental hæmorrhage come to mind readily as complications of pre-eclamptic toxæmia. Diminished utero-placental blood flow can occur in lesser degree in toxæmia and in postmaturity but may not reveal itself until after the onset of labour. Cord compression through tightening of a true knot or loops round the neck would seriously interfere with oxygenation.

Labour itself, if long enough, can cause anoxia especially after the membranes have ruptured. This comes about in two ways. First, the contracting and retracting uterus cuts down the blood-flow in the placenta; and, secondly, prolonged compression of the head reduces the blood-flow in the brain causing anoxia of the vital centres.

Signs of established or impending fœtal distress. Clinically evidence of fœtal distress is shown by changes in the fœtal heart-rate and rhythm and by the appearance of meconium in the escaping liquor. Occasionally convulsive fœtal movements may occur but this is a late sign and heralds disaster.

Normally the fœtal heart-rate slows a little during uterine contractions but recovers fully and quickly in the intervals and the rhythm remains regular. When fœtal asphyxia is developing, leading to signs of distress, the fœtal heart-rate not only slows more during contractions, but its recovery is slow and as the condition develops the rate drops lower still and the beat

becomes feeble and irregular. A fœtal heart-rate persistently below 100 beats a minute certainly indicates fœtal distress. Occasionally the first sign may be an increased heart-rate to an almost uncountable speed, but more usually there is a gradual slowing before it stops. Congenital heart block is a rare cause of a slow fœtal heart rate and carries a bad prognosis as it may be associated with other congenital cardiac abnormalities. This condition may be recognized in three ways; by noting that the slow rate has always been present (even in pregnancy); by observing that the slow rate does not vary in labour; and if possible by obtaining a fœtal electrocardiograph.

Finally, an increase in the fœtal heart-rate can be brought about by intrauterine infection or maternal hyperpyrexia due to any cause.

The sudden appearance of meconium in the liquor amnii is also a sign of fœtal distress. It is due to peristaltic movements in impending asphyxia. The appearance of meconium-stained liquor can be misleading, for if it is seen when the membranes rupture it indicates that distress has taken place at some time, but has not necessarily persisted; counting the fœtal heart-rate will decide this point. Further, stale meconium stains the liquor a greyish pale green colour, whereas when it is fresh it is a much darker green. Thick meconium sometimes drains from the vagina in breech presentation; it usually results from compression of the fœtal abdomen in the pelvis, though it could, of course, also arise from impending asphyxia in breech labour.

When there are clear-cut signs of fœtal distress in the second stage of labour there should be no hesitation in assisting delivery. The conditions governing the application of the obstetric forceps should be fulfilled, and whilst final preparations for the delivery are made oxygen should be given to the patient in the hope of improving the state of the fœtus. When the indication of forceps delivery is fœtal distress adequate perineotomy reduces the risk of adding intracranial stress to the clinical picture.

Needless to say, full preparations should have been made for resuscitation of the baby. It will almost certainly have inhaled meconium contaminated liquor, possibly infected, through paralysis of the respiratory centre by asphyxia. The management of asphyxia neonatorum is dealt with on p. 635.

Conditions which must be fulfilled before application of forceps. To apply forceps safely and successfully certain basic conditions must be fulfilled. To ignore them invites needless complications.

    (i) The presentation must be suitable.
    (ii) The head must be engaged.
    (iii) The pelvic outlet must be adequate.
    (iv) The cervix must be fully dilated.

(v) The membranes must be ruptured.

(vi) The bladder must be empty.

(vii) The uterus must be contracting and relaxing.

In the first place, *the presentation must be suitable*. The forceps can only be applied to the head of the fœtus and then only when it presents either as a vertex or as a face with the chin anteriorly placed; the after-coming head of a breech is commonly delivered by forceps. The forceps must be applied accurately to the fœtal head in the manner to be described later; otherwise dangerous compression of the skull will occur causing intracranial stress and hæmorrhage, and very likely too the attempt to deliver will fail. If the forceps slip off during traction as they are likely to do when applied with the occiput posterior, unless the head is well flexed and low in the pelvis, a complete tear of the perineum may be the result.

The head must be engaged. If the head is not engaged in the second stage of labour disproportion is present; either apparent because of extension of the head, or real from pelvic contraction. The use of forceps in such circumstances would constitute a high forceps operation, which, on account of the dangers to both fœtus and mother, must never be considered.

Even with the head engaged the *pelvic outlet must be of adequate dimensions* so that there is no serious bar to the passage of the head. If the subpubic angle is narrowed there must be adequate room in the posterior sagittal diameter.

The cervix must be fully dilated. If it is not, in the first place there will be difficulty in applying the forceps without including and tearing the cervix. Moreover a much greater traction force is needed to overcome the resistance of the cervix and this will be transmitted to the fœtal skull, often with serious consequences. Finally the attempt to deliver will probably fail. In the hands of an experienced operator forceps may be applied when the cervix is nearly fully dilated, but it is only in order to steady the head while the cervix is carefully pushed up above it, before traction is applied.

It is usually said that *the membranes must be ruptured* before forceps can be applied safely. The danger is said to be detachment of the placenta. This is largely theoretical, but intact membranes could make the application of the forceps difficult. In any case there is seldom any indication to apply forceps before the membranes rupture, and if there is it would be simple to rupture them before doing so.

The bladder should be empty. A catheter is always passed to empty the bladder as a preliminary to forceps delivery, not only in order to avoid injuring it but also to remove its inhibiting influence on retraction of the uterus after delivery and in this way to prevent postpartum hæmorrhage.

The uterus should be contracting and relaxing. Only very rarely would uterine exhaustion be so pronounced as to result in complete inactivity. If there is an indication to expedite delivery before the contractions have

returned spontaneously, oxytocin may be given by continuous intravenous infusion and then delivery completed by forceps. On the other hand a uterus so unrelaxed (in other words, in a state of tonic contraction) as to offer serious resistance to delivery would be even seen even more rarely. The treatment of the condition is dealt with in Chapter 28.

The dangers of forceps delivery

Some of the dangers inherent in forceps delivery are due to the circumstances calling for the operation rather than to the operation itself. For example, delivery by forceps is very commonly called for at the end of a long tedious first stage of labour because of either maternal or fœtal distress or both. In these circumstances nearly all the hazards related to forceps delivery occur and the dangers can be decreased only by taking the following proper measures to reduce them.

The risk of general anæsthesia during labour is mentioned on page 499. Whenever possible pudendal anæsthesia should be used in preference to a general anæsthetic. The technique is described on page 501.

If a general anæsthetic is needed, as it may be if the head requires rotation or a malpresentation requires correction, an experienced and skilful anæsthetist will ensure that the stomach is empty, that the table tilts down by the head efficiently and that a suction apparatus is available before he begins the anæsthetic. The anæsthetic agent chosen must be suitable for the operation, producing satisfactory relaxation for such manœuvres as rotation of the posterior occiput; the degree of anæsthesia need only be light for a simple low forceps operation. The difficulty of an obstetric manœuvre can be reduced by adequate relaxation and the risk of the operation thereby decreased; but too much anæsthetic (especially if it is ether) may produce a toneless uterus in and after the third stage with resulting retention of the placenta, or postpartum hæmorrhage, or both. For this reason the amount of anæsthetic should be reduced as soon as the child is delivered. The effect of the anæsthetic agent on the fœtal respiratory centre should not be overlooked and provides another good reason for curtailing general anæsthesia as soon as practicable.

When the first stage has been long there is usually a well marked caput succedaneum and this obscures landmarks on the fœtal head by which the position of the occiput is determined. Moreover, in just such a labour the occiput is often posterior. As the sutures and fontanelles are often obscured the ear is the best guide to the position of the head. The membranes have usually ruptured early allowing most of the liquor to escape; this makes rotation more difficult and increases the risk of infection. Finally, in this type of labour the fœtus is often rather large and the pelvis may be android in shape with reduction in the size of the outlet. These features

increase the risk of vaginal and perineal laceration and of fœtal intracranial hæmorrhage, facial palsy and cephalhæmatoma.

Both judgement and skill are exceptionally important in dealing successfully with the above conditions.

Some of the dangers of forceps delivery may be summarized thus:

Mother:	Infant:
Dangers of anæsthesia	Intracranial hæmorrhage
Lacerations of cervix, vagina or perineum	Facial palsy
Postpartum hæmorrhage, due to uterine atony or to cervical or vaginal lacerations	Cephalhæmatoma
Puerperal genital infection	

Spastic diplegia is sometimes attributed to instrumental delivery. It is improbable that intracranial hæmorrhage will have this effect; if the hæmorrhage is not fatal complete recovery is likely. On the other hand prolonged cerebral anoxia may well leave permanent damage; the forceps may have been used in such a case but could hardly have caused the anoxia.

Bad results from forceps delivery usually result from bad forceps delivery. The dangers will be minimal only when proper regard is given to the indications for the operation and when the exact position of the head is determined by a preliminary vaginal examination and any necessary correction made before the forceps is applied and traction made. Good anæsthesia and basic obstetric skill are no longer exceptional refinements, but are the essentials on which safe forceps delivery must depend.

Types of obstetric forceps

Although the obstetric forceps in use today are many and varied, those in each class differ usually only in minor details. In the main forceps can be classified as follows:

1. Short curved forceps.
2. Long curved forceps.
3. Kielland's forceps.
4. Axis traction forceps.

The basic construction of all modern forceps is the same in that the instrument consists of two halves meeting at the lock. Each half has a fenestrated blade which is joined to the handle by a shank. The blades have two curves; the cephalic curve in which the blade is curved to correspond with that of the fœtal head; and a curve on the edge, the pelvic curve, to correspond with that of the pelvis and to grip the head more centrally. The length of the handles and the shanks varies with the different forceps and the type of handle is variable too. Kielland's and axis-traction forceps have special characteristics.
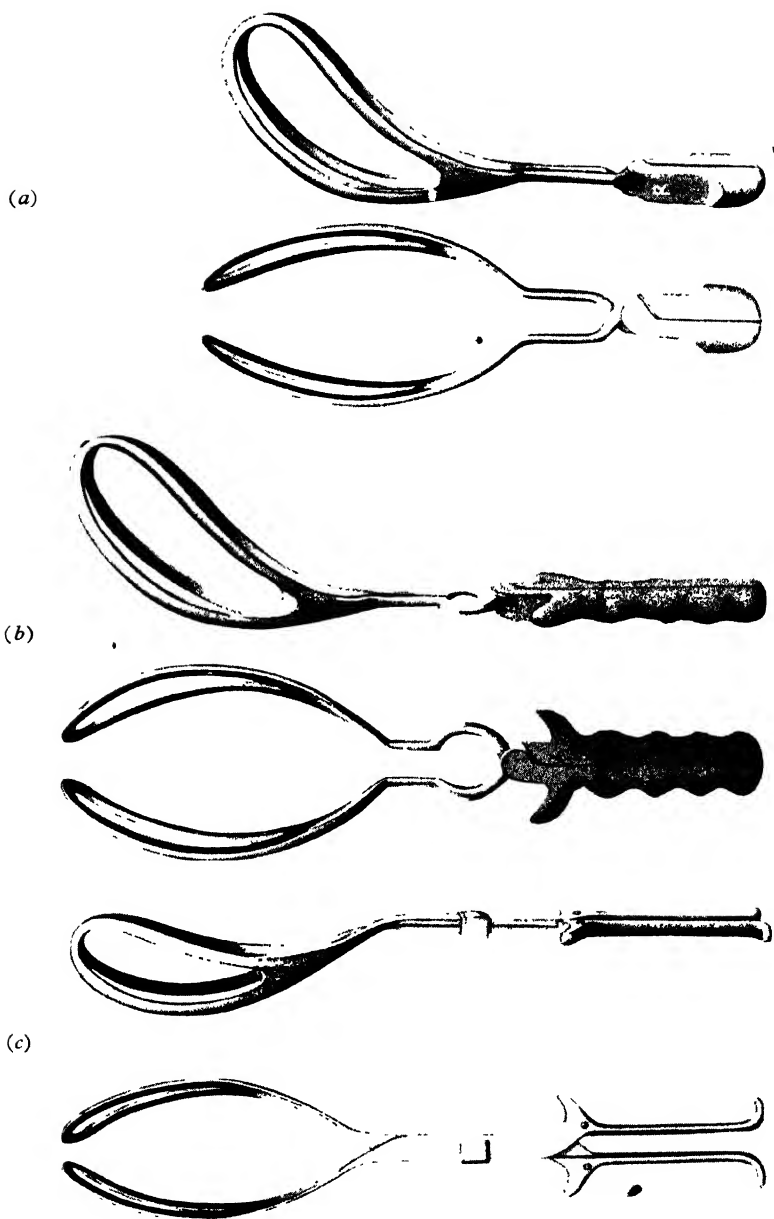
FIG. 187.

(a) Short curved (Wrigley's) forceps.
(b) Long curved forceps.
(c) Kielland's forceps.

Short curved forceps. This instrument, designed by Wrigley in 1935, is for use in the low or outlet forceps operation. It differs from the long forceps in having much shorter shanks (1 in. instead of $2\frac{1}{2}$ in.) and handles, and in being a much lighter and more delicate instrument.

Long curved forceps. Although the long curved forceps can be applied to the head which has passed only partly through the brim of the pelvis, this should never be attempted. The pelvic curve enables the instrument to be applied to the head correctly at any pelvic plane. The total length of this instrument is 15 in. and it is relatively heavily built.

Kielland's forceps. The chief advantage of this instrument is that it allows accurate cephalic application, no matter what the position or level of the head in the pelvis. If the occiput is posterior, or in a position of transverse arrest, the application is made first and next the head slightly elevated and then gently and precisely rotated bringing the occiput anterior.

One characteristic feature is the lock which allows one blade to slide on the other in the long axis and in this way permits the blades to lie at different levels when applied to a head which is lying transversely. When rotation is made as the sides of the head gradually move into the same horizontal plane with the occiput coming to the front, so do the blades applied to them by virtue of the sliding action allowed by the lock.

The other characteristic is the pelvic curve. This is initially in a backward direction and then it quickly begins its forward sweep but the tips of the blades never quite reach the plane of the shanks and handles. It is this feature which makes rotation by forceps possible; and in experienced hands it is safe and reliable as well.

Axis-traction forceps. To enable the operator to exert traction in the backwards as well as downwards when the head was at the level of the pelvic brim the axis traction forceps was invented. Angled rods and an additional handle were attached to the blades. The Neville-Barnes instrument is a simpler modification. The high forceps operation is dangerous and is not now performed, so axis traction rods are not required.

Action of the obstetric forceps. The obstetric forceps should be used only as a tractor, except in the case of Kielland's forceps.

If it is thought that forceps delivery may be indicated a full examination, including a vaginal examination, should be made on the conscious patient to ensure that conditions are suitable for a safe forceps delivery.

The operation of forceps delivery is divided into three parts:

1. The preparation necessary for the application of the forceps.
2. The application of the forceps.
3. The extraction with the forceps.

Preparation necessary for the application of obstetric forceps

(*a*) The instruments are prepared as for any other operation.

(*b*) The vulva having been shaved is thoroughly washed with soap and water and finally swabbed with a suitable antiseptic. The operation field is surrounded by sterile towels.

(*c*) Some form of analgesia should be provided. This may take the form of pudendal block, caudal or extradural analgesia, or general anæsthesia. The technique of pudendal block is described on page 501 and this should be used whenever possible in preference to general anæsthesia. A general
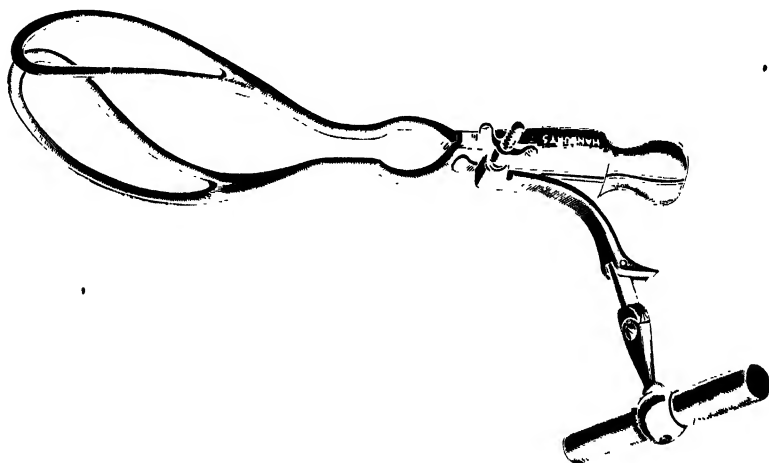
FIG. 188. Neville-Barnes forceps.

anæsthetic should only be given by one experienced in dealing with the particular complications which may arise. Unless it is reasonably certain that the patient's stomach is empty a stomach tube must be passed before the anæsthetic is begun. It is essential that the head of the table can be lowered without delay in case of unexpected gastric regurgitation.

Finally, someone experienced in the resuscitation of the asphyxiated newly born infant, should be present.

(*d*) The lithotomy position is best, provided that expert anæsthesia is available and that the head of the table can be lowered quickly. In exceptional emergency cases when these facilities are not available and pudendal block is not sufficient anæsthesia the patient may be given a general anæsthetic and delivered in the left lateral position. In this position aspiration of regurgitated stomach contents is not so likely to happen as when the patient lies on her back.

(*e*) The bladder is emptied by catheter.

(f) The preliminary vaginal examination. With the patient anæsthetized and in position, the fingers of the gloved hand lubricated with antiseptic are introduced into the vagina. This will discover how low the head is if it is not already visible and will often determine fully the whole situation, if the head is low and the fontanelles and sutures are unobscured by caput formation. If the information gained is insufficient then the whole hand must be introduced, but the perineum may need to be incised, especially when the patient is a primigravida. The first aim always is to confirm that the cervix is fully dilated, then to determine the presentation and position by feeling the whereabouts of the fontanelles and sutures. If a caput obscures them, an ear must be felt and the direction in which the pinna is pointing shows where the occiput lies. The presence or absence of excessive mould-ing of the head and its mobility will be noted and finally whether or not the obstetric outlet seems big enough to allow the head to pass. Assessment of pelvic size is by no means always easy, and only comes with experience, but the points to seek are the prominence of the ischial spines, the width of the subpubic arch and the length of the sagittal diameter of the obstetric diameter of the obstetric outlet from the lower border of the symphysis pubis to the sacrococcygeal joint. When all these items have been checked and found satisfactory, there still remains the position of the head. If the occiput is in the mid-line in front, the forceps can now be applied, but if it is lying obliquely or transversely, manual rotation will be needed first, unless Kielland's forceps are being used, when the head may be rotated with the forceps. If the occiput is posterior, unless the head is so low that the perineum is being stretched, or unless the pelvis is the transversely narrowed anthropoid type, it is almost always better to rotate the occiput to the front before the head is delivered. The disadvantage of not doing so is the increased risk of intracranial stress which goes with this position of the head.

If the head has not descended to the pelvic floor then a more serious cause for delay is likely. A flattening or even protrusion forwards of the sacrum might be felt, or the head might be found to be severely deflexed or extended. Any serious doubt about the size of the pelvis with the head arrested at this level would almost certainly make Cæsarean section the safer form of delivery. When there is malposition but no pelvic contraction mid-pelvic forceps delivery would be carried out after correction of the position.

Application of obstetric forceps

The left blade of the forceps is applied first. The fingers of the gloved right hand are passed into the vagina. The left blade of the forceps is then held between fingers and the thumb of the left hand by its handle, and passed between the fœtal head and the palmar surfaces of the fingers of the

right hand, thus protecting the birth-canal from injury. The handle is held well over the mother's abdomen, and inclined to the mother's right side, so that it is almost parallel with her right inguinal ligament. As the blade passes up into the birth-canal the handle is carried backwards and towards the mid-line, thus following the direction of both the pelvic and the cephalic curves.

The fingers of the right hand are now withdrawn after ascertaining that the blade lies next to the head and in accurate position.

FIG. 189.   Introduction of the forceps. Stage 1.

The fingers of the left hand are now introduced along the right side of the mother's pelvis, and the right blade of the forceps is held as before and passed in a similar manner. Its external visible portion will thus lie above and across the handle of the left blade. The two blades should now lock without any difficulty and are ready for traction to be applied. Occasionally difficulty may be experienced in locking the forceps. This may be due to relatively trivial faults such as to the fact that both blades have not been passed the same distance or that one blade has rotated after its introduction. A more serious cause, however, and one which should always be borne in mind, is that the exact position of the fœtal head has been diagnosed incorrectly and that the instrument has been applied to a fœtal skull which is in the oblique or transverse diameter of the pelvis. If the forceps do not lock or the handles do not close together the correct procedure is to remove the instrument completely and to re-examine the

FIG. 190.   Introduction of the forceps. Stage 2.

FIG. 191.   Delivery with the forceps. Stage 3.

position of the fœtal skull. This may have to be repeated more than once until an accurate application is made. At first the direction of the pull will be downwards and backwards towards the anus, but as the head advances it will be made in a downward and forward direction in order to follow the curve of the pelvis.

Forcible extraction should not be used. When the head is crowned, the blades should be unlocked and removed gently and separately.

Application of the forceps to a face presentation. If the head is delayed in the pelvic cavity and the chin is pointing forwards, and there is no contra-indication to its use, the forceps may be used to assist delivery of the child. The method of application is the same as that already described, but the handles should be kept well forward in order to avoid the blades grasping the neck. If the chin is pointing backwards, the face should be rotated manually and the forceps then applied. When the head is large and does not rotate or cannot be rotated, labour is obstructed and should be dealt with as described on p. 359.

Application of the forceps to the after-coming head. In some units the forceps is applied to the after-coming head in breech delivery as a standard procedure; in others only when there is delay with the head in the pelvic cavity or on the perineum. Before the forceps is applied, the body of the child must be drawn forward if the occiput is in front, and when the instrument is applied its handles will be as shown in Fig. 126, page 384.

Relation of the blades of the forceps to the head of the child. When applying the forceps by the method described, the blades have been passed so that they lie in relation with the sides of the mother's pelvis without any particular regard to the position of the head of the child. So far as the head of the child is concerned the proper diameter to be grasped is the bi-parietal. In the majority of cases in which delivery by the forceps is necessary this is the diameter that is grasped, since the forceps is most often used after the long diameter has rotated into the antero-posterior diameter of the cavity (Fig. 192). If the head is lying diagonally, an oblique diameter stretching between a point a little in front of one parietal eminence to a little behind the other will be the part of the head between the blades of the forceps and it will not be grasped so securely as it should be, and as a result, not only may the forceps slip when traction is applied and probably lacerate the vaginal walls, but also the head being gripped, will be prevented from rotating into the roomier antero-posterior diameter and will be dragged forcibly through an unfavourable one. Hence if manual rotation has not brought the occiput fully forward and if the head is lying obliquely, it is better to apply the blades of the forceps to the sides of the head rather than to the sides of the pelvis.

When the forceps is applied to the face the blades rest against the sides of

the head in a diameter approaching the occipito-mental (Fig. 193). When the forceps is applied to the after-coming head the blades grasp the bi-parietal diameter (Fig. 194).

FIG. 192. Position of the blades of the forceps during extraction of a vertex presentation.

The blades of the forceps lie in the submento-vertical diameter and grasp the bi-parietal diameter.

Extraction by the forceps. The handles being held lightly with the fingers of the right hand, the direction of the traction will vary according to the position of the head of the child. This direction, which at first should be as far backwards as possible, is gradually shifted forwards as the head descends until the outlet of the vagina is approached, when it should be forwards. It is better to remove the forceps when the head of the child is crowned, since the danger of rupturing the perineum thereby will be lessened.

Precautions to be taken during the extraction

(a) The direction of the pull must be in the axis of the birth-canal.
(b) The strength of the pull must be regulated.
(c) The grip of the forceps must be relaxed between pulls.

The direction of the traction has already been dealt with. The common practice of using great force if the head is not moving easily is most reprehensible, and is an indication that the operator either is trying to deliver
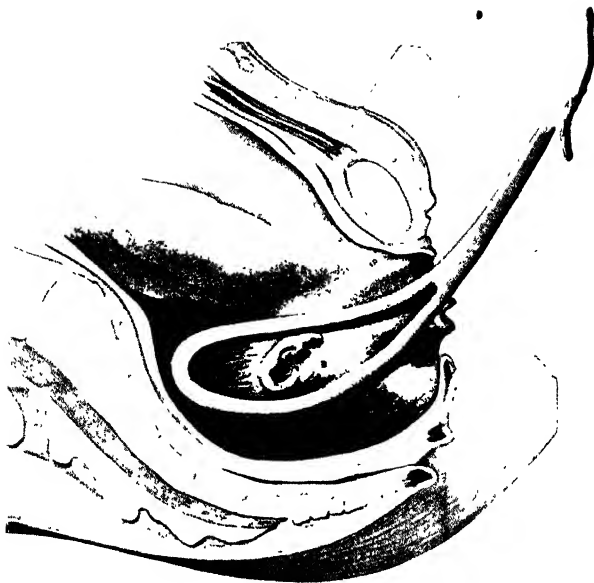
FIG. 193. Position of the blades of the forceps during extraction of head in mento-anterior position.
The blades of the forceps lie in the occipito-mental diameter and grasp the head in the bi-zygomatic diameter.

FIG. 194. Position of the blades of the forceps during extraction of the after-coming head.
The blades lie in the submento-vertical diameter and grasp the head in the bi-parietal diameter.

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too quickly or has not correctly diagnosed the cause of the delay and should not be using the forceps at all. If the use of the forceps is persisted in, even if the head is finally extracted, the mother runs a great risk of being seriously torn, and the child will almost certainly be dead. Rather more force is required when delivering with the long curved forceps than with axis-traction forceps, but certainly not more than can be exerted with the forearm alone. Traction should generally be made intermittently and delivery made easier by an episiotomy.

The use of Keilland's forceps. Kielland's forceps should only be used by an experienced obstetrician as the skill required for their use can only be acquired by a long apprenticeship. In inexperienced hands this is a dangerous instrument, and may be the cause of severe vaginal lacerations.

Before applying the forceps it is essential to find out the exact position of the head in the pelvis by vaginal examination. When it is lying antero-posteriorly or slightly obliquely correct application of the forceps will not be difficult. But if the head lies transversely the special technique for applying Kielland's forceps is called for. The object is to fit the blades accurately to the sides of the fœtal head. There are three methods of application to the head lying in the position of transverse arrest:

(i) Classical (Kielland's).
(ii) Wandering.
(iii) Direct.

Having completed the preliminary vaginal examination and determined the exact position of the head in the cavity, the forceps locked together is held before the vulva in the position to be taken up when applied to the head; one blade will be anterior and the other posterior. Whatever method is used the anterior blade is always applied first; so the anterior blade is retained in the hand and the other returned to the instrument table. The methods differ only in the application of the anterior blade.

Classical method. The anterior blade is taken lightly with the fingers and thumb of the right hand and with its *cephalic* surface directed forwards, guided by the fingers of the left hand between the head and the symphysis pubis. When the blade of the instrument is entirely above the head it is gently rotated through 180 degrees bringing the cephalic surface into its correct position for the head, which it will now occupy when the blade is slightly withdrawn.

Wandering method. The anterior blade is taken as before and is guided into the pelvis *behind* the head, the cephalic surface properly facing the head. It is now slid gently round the pelvis, keeping as close as possible to the head, over the forehead and then comes to rest fitting over the anterior parietal eminence.

Direct method. This is used only when the head is low down on the pelvic floor and the fit of the head not too tight. The tip of the anterior blade with the handle as far back as possible is applied to the side of the head anteriorly and gently slipped up over the parietal eminence behind the symphysis, its cephalic surface hugging the head in transit. The posterior blade is introduced behind the head, the fingers of the left hand guiding it into position and keeping it close to the head all the way. If there is difficulty with the posterior blade it may mean that it is not within the rim of the cervix or that there is too little room for safe application and delivery. With the blades satisfactorily applied the handles are locked and it will now become apparent at what different levels the blades are lying for the handles temporarily seem unequal in length.

Rotation of the head. Force is never used and rotation is done with three fingers of one hand only. Rotation may be made first at the level of arrest but if not immediately easy the head should be elevated slightly and rotation tried again. Sometimes rotation will be easier after traction has caused the head to descend to a roomier level.

Traction is made in the line of the handles and is exerted by two fingers only hooked over the proximal shoulders of the handles.

Rotation and traction are never done together but one after the other. Sometimes spontaneous rotation takes place during traction and must not be impeded. The handles should never be compressed.

Failed delivery with the forceps

Each maternity unit has amongst its emergency admissions a number of cases classified under this heading. Fortunately the figures to-day are far smaller than they were even 10 years ago, for the dangers to mother and baby associated with failed forceps delivery are potentially serious and are directly proportional to the lack of skill and the force employed in the unsuccessful attempts at delivery. For instance, one comparatively recent report showed that 7 per cent of the mothers died and 43 per cent of the babies were either stillborn or died soon after birth.

The most common cause is lack of obstetric skill and following on this, poor clinical judgement. How else could forceps be applied repeatedly and strong traction made with the cervix not fully dilated often with the head in malposition? The serious criticism is made not so much against *attempting* to apply forceps or *attempting* traction, but against *persisting* doggedly in such endeavours in the face of obvious difficulties.

It might be argued that a trial of forceps is sometimes practised now; so it is, but when done it should always be under the ideal conditions of a fully staffed obstetric unit with the necessary skill and operative facilities which such a procedure demands.

The circumstances surrounding failed forceps delivery are mostly

commonplace, either the cervix is not fully dilated or the head is in mal-position, usually occiput posterior. Attempts to apply forceps with the head not yet engaged fortunately are not often made nowadays, for the dangers are proportionally greater. The actual damage to the patient caused through badly used forceps may be a severe laceration of the cervix when either the blades of the forceps are applied outside it because of incomplete dilatation, or the head forcibly dragged through resulting in a split cervix, possibly extending into the lower uterine segment. Sometimes an extensive tear of the upper vagina is caused when the forceps are roughly forced on to a head lying in a bad position; or it may result from attempts to rotate the head with ordinary long curved forceps. If the obstruction is at the brim, the uterus itself may have been perforated by a blade of the forceps causing uterine rupture or tearing of the bladder or rectum. A complete tear of the perineum into the anal canal, not an uncommon accompaniment of failed forceps, comes about from a combination of roughness and misapplied force, both no doubt, due to a final desperate effort to deliver.

The effect on the patient of many of these obstetric insults, even if she has avoided a badly given or prolonged anæsthetic, is to cause shock from the trauma inflicted or the resulting hæmorrhage or both. Sepsis naturally is likely to follow and even nowadays can produce serious consequences. The damage to the fœtus is almost always that of intracranial hæmorrhage and it may be dead on admission or die soon after ultimate delivery; or short of death there may be permanent cerebral damage resulting in spastic palsy. Cephalhæmatoma and facial palsy are the comparatively minor accidents to the unfortunate fœtus. If only the preliminary vaginal examinations were always carried out conscientiously and carefully, the serious damage done in many cases of failed forceps could be entirely avoided.

VACUUM EXTRACTOR OR VENTOUSE

The idea of extracting this fœtal head by means of a vacuum cup applied to the fœtal scalp has been considered by obstetricians for the past 250 years.

Younge in 1706 used a glass suction cap, but the first practical instrument seems to have been designed by Simpson in 1849. There is an account of his 'air tractor' with a discussion of the mechanical and obstetrical problems in his *Obstetrics, Memoirs and Contributions*, 1855, but little if any use was made of his instrument.

During the following century several types of cap were described but the modern vacuum extractor was introduced by Malmström in 1954 and it is his model which is now being widely used especially on the continent where it is called the ventouse.

Malmström's extractor (Fig. 195) consists of a metal suction cup attached by a chain, running through a rubber tube, to a metal handle and connected by rubber tubing to a glass container with a pressure gauge and a pump. The metal suction cups are made in three sizes 40, 50 and 60 mm. in diameter and the largest possible is used depending on the degree of dilatation of the cervix.
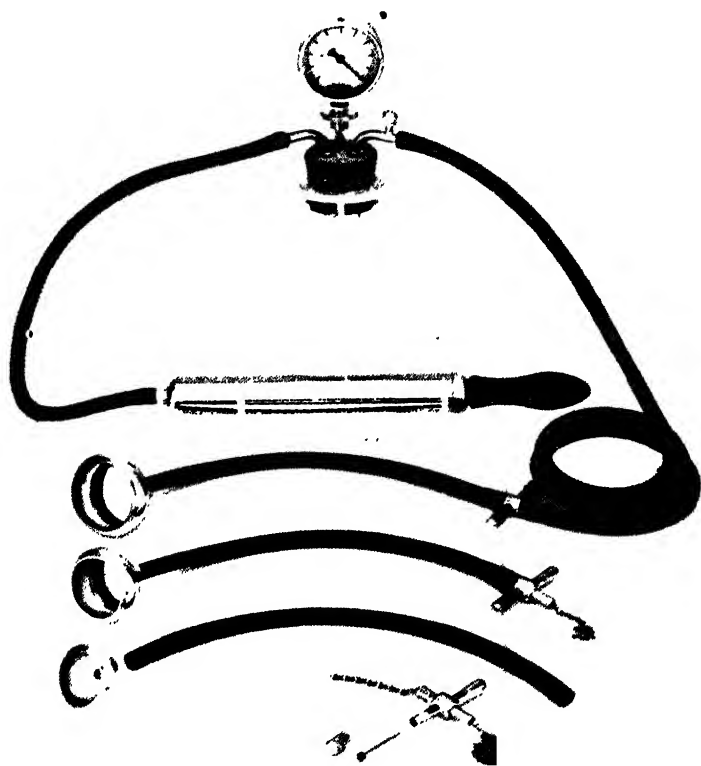
Fig. 195.   The vacuum extractor. (AB. Vacuum Extractor, Allen & Hanbury's Ltd.)

Application. Local infiltration of the perineum with 0·5 per cent lignocaine is the only anæsthesia usually needed.

The cup is introduced sideways into the vagina pressing it backwards against the perineum and then guided into place on the scalp, care being taken that neither the cervix nor the the vaginal wall comes between the cup

and the fœtal scalp. Whilst the operator holds the cup in the correct position an assistant uses the pump to create a vacuum commencing with 0·2 Kg. per sq. cm. thereafter gradually raising the negative pressure 0·1 Kg. per sq. cm. at two minute intervals till 0·8 Kg. per sq. cm. is attained. Failure to maintain the negative pressure indicates that either the cup is incorrectly applied or that the instrument is faulty.

The negative pressure causes an artificial caput succedaneum or 'chignon' to be formed within the cup and when it reaches 0·8 Kg. per sq. cm. the cup is completely fitted with scalp, ensuring maximum adhesion and traction can be commenced.

Traction. Traction on the handle is made as nearly as possible vertically from the cup as an oblique direction of traction will tend to pull it off. Traction is made intermittently with the uterine contractions, the direction changing as the head descends through the birth canal and is finally delivered.

Immediately after delivery and removal of the cup the baby has an unsightly artificial caput or chignon where the cup has been applied, but this rapidly diminishes in size and within a few hours only a faint ring can be seen where the edge of the cup was applied to the scalp. It is important after delivery to reduce the vacuum as slowly as it was created as this tends to diminish the risks of damage to the scalp.

Indications. These are similar to those for which obstetric forceps are used. It may also be used to accelerate dilatation of the cervix in cases of prolongation of the first stage of labour (primary uterine inertia) when forceps could not be applied and the alternative might be a Cæsarean section.

Contra-indications. The vacuum extractor should not be applied to the face or breech. In cases of urgent fœtal distress in the second stage of labour the operation takes too long and a forceps delivery can be effected much more quickly. As it is not possible to make very strong traction without pulling the cup off, it is not, therefore, suitable for cases with disproportion.

There is some doubt as to its safety when used on premature babies, some authorities claiming that there is an increased risk of intracranial hæmorrhage and that forceps are safer since they protect the head from compression by the soft tissues of the birth canal.

Necrosis of the scalp, cephalhæmatoma and intracranial hæmorrhage have been reported following vacuum extraction, but in a number of these cases the cup had been applied for long periods and strong traction had been used to overcome some degree of disproportion.

The place of the vacuum extractor in obstetric practice has not yet been decided but whatever its faults and limitations are there is no doubt that it is a valuable instrument with which to treat some cases of prolonged first stage of labour when the cervix is slow to dilate with no obvious evidence of disproportion.

VERSION

Version means turning the fœtus so that the lie or presentation may be changed. When the head is made to present it is called *cephalic version* and when the breech *podalic version.*

Version can be external, internal or bipolar.

External version

When the fœtus is turned by manipulation which involves using both hands on the patient's abdominal wall, it is known as external version. Nearly always it is the head that is made to present and then it is called external cephalic version. Occasionally this is not possible in cases of transverse lie, and so breech presentation is chosen as second best and external, podalic version is then done.

Indications. The most common indication for external version is to turn a breech into a head presentation in the antenatal clinic, usually between the 32nd and the 36th weeks of pregnancy, although it can often be done later.

Contra-indications. The commonest reason for wishing to avoid external version is when the patient has bled. Antepartum hæmorrhage could have resulted from some degree of placenta prævia or from accidental partial separation of the placenta, even without signs of toxæmia. In either case it would be obviously hazardous to proceed to external version. Hypertension or proteinuria would also be a contra-indication. External version would not be done if the patient is ultimately to be delivered by elective Cæsarean section.

Sometimes version has been left too late and the fœtus which presents as a breech is judged too big to turn. This often means that there is an insufficiency of liquor amnii, the uterus moulding itself to the outline of the fœtus. In such a case the breech is often deeply engaged, giving the firm impression that it could not be disimpacted. In all these circumstances version should not be attempted; there must always be a reasonable hope of easy success because force must never be used.

Technique. The patient lies on her back. Manipulations are done only when the uterus is relaxing and then gently and unhurriedly. The abdomen

is palpated methodically to confirm the presentation and the suitability of the case for version. The fœtal heart is listened to. The patient's abdomen is dusted with talcum powder.

Breech presentation. The first step is to disengage the breech by lifting it out of the pelvic brim. This is done by slipping the finger tips of both
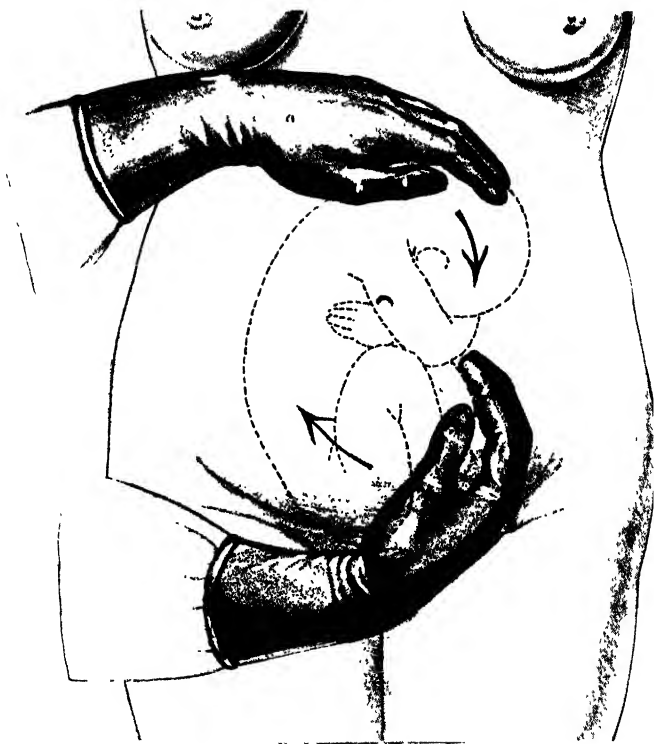
FIG. 196.   External cephalic version.

The patient is lying on her back. Note that the direction in which the child is moved is that which tends to increase rather than to diminish flexion of the head and spine. The use of gloves is not necessary.

hands beneath it and manœuvring it out to that iliac fossa corresponding to the side on which the fœtal back is lying. Supporting the breech here by means of one hand, the other hand seeks out the head in the opposite uterine cornu and then with both hands working in unison, one lifting the breech further up on one side and the other firmly pressing the head down on the other side, the fœtus is progressively turned. In some cases it goes round quickly and with the greatest ease. In others careful and painstaking manipulation is necessary.

Almost always version is easier when the fœtus is turned in the direction in which it is facing. In this way flexion tends to be increased and so the fœtal bulk made smaller and easier for turning. When the head is ultimately brought over the brim it should be pressed down into the pelvis to help in maintaining the head presentation. Not uncommonly it will not be possible to cause the head to engage immediately after version, for the head may have become deflexed. The fœtal heart should be auscultated after version, and during version if the manipulation is protracted. It is very common to find that the fœtal heart slows when the head is pressed on, but it recovers again quickly when pressure is released. Immediately after version the fœtal heart is often slow but the normal rate soon returns in uncomplicated cases.

Before the patient leaves the couch after version the introitus is inspected to note whether or not any bleeding has taken place. The patient should be seen again within the next week to see that the head still presents and to determine if it engages in those cases in which engagement was not possible immediately after version.

It is usually easier to turn a breech with flexed legs than the more common breech with extended legs, for the former is usually unengaged, whereas with the latter the opposite is true. Extension of the legs is no bar to version although their splinting action tends to limit flexion of the trunk and also the more streamlined presenting part sinks more deeply into the pelvis. Nevertheless if it is possible to lift the breech out of the pelvis version may be attempted. But no further endeavour must be made if it cannot. In such cases it is sometimes helpful to admit the patient to hospital and attempt version in the morning before she rises from bed. The Trendelenberg position is also occasionally used to disengage the breech before version is attempted.

Causes of failure. Version may fail for one of several reasons and should never be looked on as a challenge. Sometimes it is obvious that the fœtus has become too big, or there is a deficiency of liquor amnii. But when these features are not present and the chance of success seems good, failure is often due to part of the breech still being within the pelvis. Very occasionally there is a developmental abnormality of the uterus such as uterus arcuatus or uterus subseptus, when the short septum in the fundus prevents the head from escaping from the cornu. A cornual implantation of the placenta is thought to have a similar effect and has been thought in recent years to be a common cause of persistent breech presentation. Shortening of the umbilical cord, or looping of the cord round the neck or a limb may prevent version and would constitute an additional danger to the fœtus through cord obstruction or placental separation.

Occasionally the presence of another fœtus in unsuspected twin pregnancy is the reason why version fails. When the patient is very obese or when the placenta is attached to the anterior uterine wall, the definition of

the fœtus is obscured enough to make successful version less likely. In much the same way, if version is tried too early the fœtus may be too small to define accurately. A very important, yet not very common, cause of failure of version has been left purposely to the last. It is inability of the patient to relax. Unless the abdominal wall has been made tender by previous unsuccessful attempts the vast majority of patients are able to relax sufficiently for version to be undertaken safely and successfully.

Version under anæsthesia. This is only indicated if the anæsthetic will eliminate the factor causing failure. Apprehension will cause involuntary contraction of the abdominal muscles, which anæsthesia can overcome, but most anæsthetics (including relaxants) have no effect on uterine tone. Exceptions are chloroform and halothane (fluothane), and the latter may be ideal for this purpose.

If an anæsthetic is administered particular care must be taken not to use any undue force during attempts at version.

Risks. When version is properly done in carefully selected cases it carries very little risk. Anæsthesia by removing the patient's ability to resist force adds considerably to the dangers. This is not to say that it should be avoided, but only to emphasize that the use of anæsthesia calls for the proper indication and for experience on the part of the operator.

Version can cause partial separation of the placenta and accidental hæmorrhage, rupture of the membranes and premature labour or prolapse of the cord. If there is unsuspected placenta prævia it may cause bleeding. Obliteration of the cord circulation may be caused by a knot.

Rupture of veins in the broad ligament with formation of a broad ligament hæmatoma or hæmoperitoneum can be caused.

Transverse and oblique lie. Unless there is an obvious simple cause such as hydramnios or lax abdominal muscles, the possibility of placenta prævia being present should be thought of and manipulation to bring the head into the pelvic brim done with gentleness and circumspection. If there has been any previous bleeding version should be avoided.

When the head has been brought over the brim an attempt is made to make it engage and if this can be done satisfactorily disproportion at the brim and placenta prævia are excluded. If it cannot be made to engage further investigation will be needed and this may take the form of pelvic examination to detect a pelvic tumour or contraction; or X-ray pelvimetry or placentography.

Internal version

Internal version can be done only in labour. By this manœuvre the presentation and often the lie of the fœtus are altered by passing a hand inside the uterine cavity; the other hand manipulates *via* the abdominal wall. In order for internal version to be possible the cervix must have

dilated sufficiently to allow a hand to pass through it, at least four fingers dilatation. It is always *podalic version* and one or both legs are brought down as part of the manœuvre. The patient should always be deeply anæsthetized.

Indications. Almost the only indications in modern practice are a shoulder presentation or a transverse lie in the case of the second of twins. Very occasionally there might still be a place for it in the management of placenta prævia of lesser degree, when rupture of the membranes has not stopped the bleeding and the baby is either very premature or dead.

FIG. 197. Internal podalic version. Stage 1. Shoulder presentation.

In a shoulder presentation it matters little which hand the operator uses internally. In this case he has introduced the right hand to grasp the lower leg of the fœtus and bring it down. His left hand, working outside the sterile sheet, is coaxing the head out of the iliac fossa.

In prolapse of the cord in a multipara when the cervix is not quite fully dilated, the head high and the baby alive, it might be done in order to deliver the child as a breech if facilities for Cæsarean section were not available.

In former years internal version was a very common way out of almost any obstetric difficulty; but it was dangerous for the fœtus, as it was then practised particularly in cases of disproportion. It would never be done

now in the presence of pelvic contraction, for the forecoming head has a much better chance of slowly moulding successfully, than the essentially abrupt passage of the after-coming head in breech delivery, which may also become fatally delayed.

Contra-indications. Internal version is emphatically contra-indicated when labour has been obstructed for so long that the lower uterine segment has become dangerously thin and distended. In these circumstances the fœtus is almost always dead and either a destructive operation or Cæsarean section would be far safer; if the fœtus is alive Cæsarean section would be indicated.

FIG. 198.   Internal podalic version. Stage 2. Shoulder presentation.
The lower leg is being brought down causing the back to rotate forwards. If the upper leg had been chosen the back would have turned posteriorly. The head has almost reached the fundus.

It could not and therefore would not be done if the membranes had ruptured some time previously and the liquor had drained away leaving the fœtus closely enveloped by the uterus and immobile. Similarly internal version is obviously not possible when the cervix is insufficiently dilated to admit the hand.

Almost always when the fœtus is dead version is best avoided and decapitation or craniotomy should be done instead.

In pelvic contraction version is always contra-indicated; if the foetus is alive Cæsarean section is the alternative to forceps delivery, and if it is dead either a destructive operation or Cæsarean section is to be preferred.

Technique. As the most common indication for internal version in modern obstetrics is a shoulder presentation the manœuvre for changing this to a breech will be described first.

Shoulder presentation. The ideal moment for internal version is when the cervix is four fingers or more dilated and the membranes still intact. This
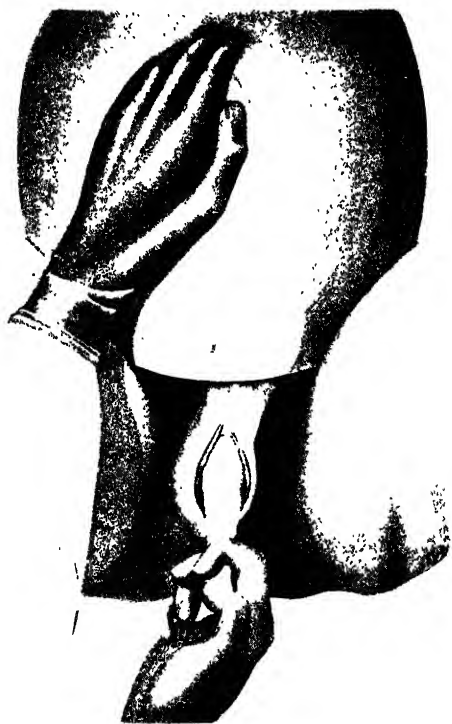
FIG. 199.   Internal podalic version. Stage 3. Shoulder presentation.

The foot and leg have been brought through the introitus and the head has reached the fundus. If the foetus seems bigger than average, the other leg will be brought down as well, and should the cervix be fully dilated, breech extraction would probably follow.

may be the state of affairs with a second twin soon after the delivery of the first twin, but is rarely found with a shoulder presentation in a single pregnancy. Except with a second twin, Cæsarean section is often preferable (see p. 390). The patient needs to be fully relaxed under general anæsthesia.

She is placed in the lithotomy position and the vulva cleaned with anti-septic lotion. Sheets and towels surround the operative field and the bladder is emptied by catheter. Palpation of the abdomen over the sterile sheet confirms the side on which the head is lying and that the uterus is relaxing. A careful vaginal examination is then done and the degree of dilatation of the cervix and the size of the pelvis estimated. The safety of the cord is confirmed, and then the whereabouts of the head, whether the back is in front or behind and the position of the limbs are determined. In a shoulder presentation an arm very commonly prolapses and this has to be distinguished from a leg. The great mobility of the digits is the distinctive feature of the hand whilst the heel immediately identifies the foot.

The next step is to grasp a foot and bring down a leg, but before doing so the membranes should be ruptured if they have not already broken. The operator's other hand working outside the sterile sheet on the abdominal wall is of great help in guiding the internal hand, and if need be in manipulating the foot to within grasp.

In practice it does not greatly matter which hand is used internally, but in theory if the head lies to the patient's left side the operator uses his right hand internally; and if to the patient's right side the left hand internally.

The foot to grasp varies according to whether the fœtus is lying dorso-anterior or dorso-posterior. The principle is always to end the manœuvre with the fœtus's back directed anteriorly. Hence if it is lying dorso-anterior the lower foot of the fœtus is grasped and brought down and its back will then stay in front. On the other hand when the position is dorso-posterior the upper foot is taken and drawn down and the effect of this is to rotate the fœtus's back to the front as it comes down.

As the leg is being brought down by the operator's internal hand, his other hand on the patient's abdomen gently manipulates the head from the iliac fossa up towards the fundus, for internal version is not achieved only by internal manipulations, it is a combined internal and external manœuvre. In conducting intra-uterine manipulations it is of the utmost importance to be gentle. Nothing should be done during a uterine contraction and the hand must be kept quite still until it passes off.

It is usual to bring down only one leg, even when breech extraction is to follow immediately and to deliver as a half-breech. If, however, the fœtus seems bigger than average it is better to bring down the other leg too, either with the first or after it. If the dilatation of the cervix permits it, breech extraction will now follow and it is done in the manner described on page 377. When the fœtus has been delivered the operator should pass his hand inside the uterus again to make sure it has not been ruptured.

Head presentation. The abdominal examination confirms on which side the back is lying for this determines which hand is used for the internal

manipulation. When the back lies to the left the operator uses his left hand and when to the right, the right hand. Only in this way will the palm of his internal hand correspond with the position of the legs of the fœtus. Having introduced the correct hand the head is pushed into the iliac fossa of the side on which the back is lying. It is then slid gently up the ventral surface of the fœtus and at the same time the outside hand presses the breech over and down the side of the uterus opposite to the back. A foot in this way
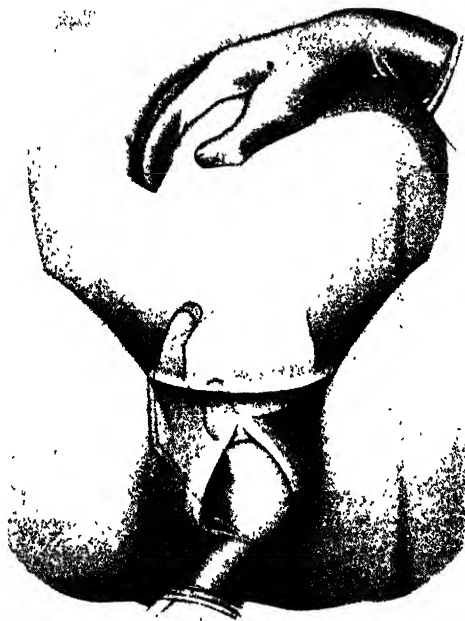
FIG. 200. Internal podalic version. Head presentation.

The hand whose palmar surface corresponds with the fœtal abdomen (in this case, left) is passed through the cervix and displaces the head into the iliac fossa on the same side as the back. The operator's outside hand, working over the sterile sheet, coaxes the breech and leg down to within the grasp of the internal hand.

comes within reach of the internal hand which grasps it and draws it down; it is immaterial which foot is seized in this instance. The outside hand as before, working in unison with the hand in the uterus works the head up to the fundus. It is more risky procedure than when the fœtus is lying transversely so that existing conditions must be favourable fully to justify its use.

Risks. It is difficult to think of any obstetric procedure which carries a greater risk for both mother and child. This is because its safety and success depends on the good judgement and skill of the operator and because the conditions for which it is indicated are inherently dangerous. Breech

extraction, prolapse of the cord and placenta prævia treated by this method are hazardous for the fœtus, particularly from either intracranial hæmorrhage, or compression of the cord or the low lying placenta. The danger to the mother lies chiefly in the likelihood of rupture of the uterus; Cæsarean section is often a safer alternative. Even when the version has been easy the uterus should always be explored after delivery to make sure that there is no rupture.

The cervix may be split or the vagina or perineum badly lacerated. Hæmorrhage would be expected from any of these traumatic complications, but in rupture of the uterus the external loss may be very little.

Today except in special circumstances, it is seldom that internal version would carry less risk than Cæsarean section.

Bipolar version (Braxton Hicks's manœuvre)

In 1860 John Braxton Hicks published his method of combined external and internal version. It was one of the most outstanding contributions to the obstetrics of his day for it removed many of the dangers of internal version and, whilst its use was advocated for correcting all kinds of malpresentations as well, its main use was in the management of lesser degrees of placenta prævia. Hicks wrote 'Turn, and if you employ the child as a plug the danger is over . . .'.

Bipolar version can be done at an earlier stage in labour than can internal version for it only requires the cervix to be sufficiently dilated to admit two fingers. This type of version is always podalic and one leg is brought down through the cervix.

This manœuvre, always technically difficult, is obsolete today and is only mentioned for historical interest. It has been replaced by Cæsarean section.

CRANIOTOMY

Craniotomy is done when the fœtus is dead and labour obstructed by apparent or real cephalo-pelvic disproportion. Its aim is to reduce the size of the head so that delivery may be affected with minimal disturbance to the patient. It is also done in cases of unmistakable hydrocephalus.

Indications for craniotomy. (1) When the fœtus is dead but conditions are suitable for assisted vaginal delivery, for instance an impacted persistent occipito-posterior position of the vertex or a mento-posterior position of the face in the absence of grass cephalo-pelvic disproportion. In persistent occipito-posterior position difficulty has often arisen because the pelvis is

of the android type or the baby is excessively big. The after-coming head of a breach presentation may become obstructed from extension or from unsuspected pelvic contraction.

With any serious degree of cephalo-pelvic disproportion Cæsarean section must be considered as alternative treatment, and may often be safer.

(2) Hydrocephalus. In this condition it is only when the head is present-ing that it is perforated. When the breech presents the size of the head can be reduced by decompressing it *via* the spinal canal. The danger of hydro-cephalus when the head presents is that the cervix may begin to split well before it has become fully dilated, so greatly does it have to stretch to encompass the enlarged head. When the diagnosis has been made ante-natally (and it should be easily recognized), the principle is to allow labour to begin, but as soon as the cervix is dilated enough (usually three fingers) to allow it the head is perforated with a wide-bore needle and stylet. The excess cerebro-spinal fluid escapes quickly and the head collapses. Labour then proceeds normally; when the hydrocephalic head is after-coming in breech delivery it is collapsed after the shoulders have been delivered by passing a straight metal catheter up the spinal canal *via* the spina bifida if one is present; or by opening the spinal canal in the upper dorsal region and passing the catheter in at that level. After decompression the head will be delivered easily by traction on the trunk.

Technique. Delivery in obstructed labour is composed of two stages: (1) Perforation and (2) Extraction.

The preliminary preparations are the same as for any vaginal obstetric operation.

1. *Perforation*

Oldham's perforator (Fig. 201) consists of two halves joined together by a bolt. Each half has a cutting blade, a shank, and a handle. Where the top of

FIG. 201.

the shank passes into the blade it is broadened out, so as to form a shoulder. If this instrument is not available in an emergency the head can be per-forated with a pair of sharp-pointed scissors.

The patient is placed in the lithotomy position and, if the head is not fixed in the pelvis, the assistant should press down the fœtus from the abdomen so that the head may remain steady.

It is important that the cervix should be fully dilated (except in hydro-cephalus) before the perforation is commenced since, when the woman is at term, great difficulty may be encountered in trying to deliver the shoulders through an imperfectly dilated cervix, and the danger to the mother will
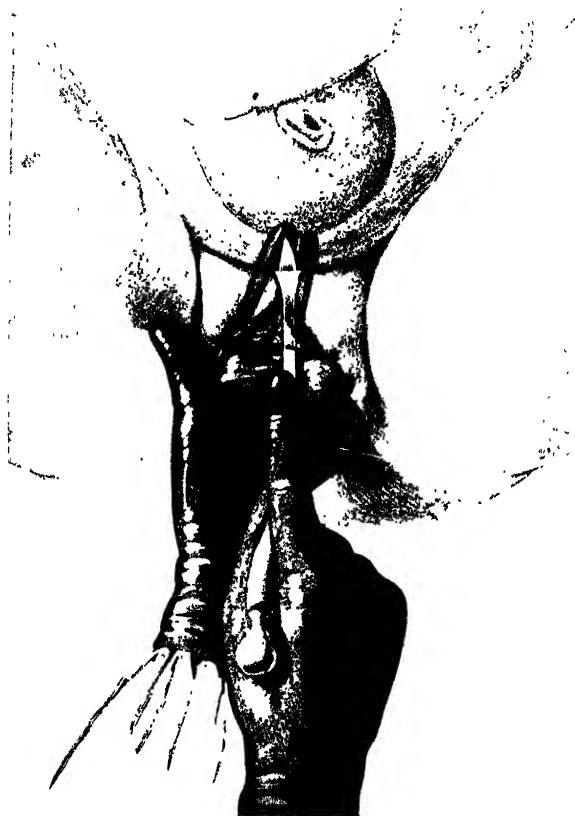
FIG. 202.   Perforation of the fœtal skull. Stage 1.

Showing the perforator guided to the child's head by the index and middle fingers of the left hand of the operator. The head in the figure is not fixed and would be held at the brim by an assistant.

be materially increased from the sharp edges of the perforated skull which may tear the walls of the birth-canal.

The operator inserts his left hand into the vagina until the finger-tips impinge on the head. Grasping the perforator in the manner shown in Fig. 202, the point protected by the fingers of the left hand is guided to a

portion of the scalp which covers a frontal bone. To ensure that the point of the perforator is at right-angles to the bone to be perforated, the shank of the instrument is next placed against the perineum, after which the point is made to perforate the bone by a rotating movement. If it is sought to perforate the bone by a sharp thrust, the instrument may slip off and

FIG. 203. Perforation of the fœtal skull. Stage 2.

Showing the perforator pushed in as far as the shoulders of the blades, the handles approximate and parts of the blades separated.

seriously injure the maternal tissues. When the perforator has been forced into the cranial cavity as far as its shoulder, the operator by approximating its handles and so separating the points, lacerates the bone (Fig. 203). The handles are then separated, and rotated a quarter of a circle, and by again approximating the handles a laceration is made in the bone at right angles to the first one. It is necessary for the bone to be perforated and not a

fontanelle or suture, since the tendency is for an opening between bones to be closed by the sliding of one bone over the other from the pressure on the head. The brain is then broken up by stirring with the perforator.

2. *Extraction*

In cases of hydrocephalus labour may proceed spontaneously after perforation and there is sometimes no need to do more. Otherwise traction on the scalp with toothed forceps (e.g. Morris's) will effect delivery, and if the cervix is fully dilated it is convenient to do this under the same anæsthetic.
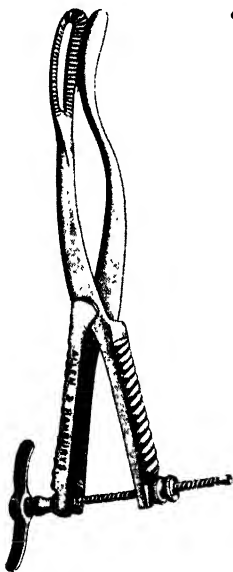
FIG. 204.   Cranioclast.   FIG. 205.   Combined caranioclast and cephalotribe.

In other cases after perforation the head may be extracted by the forceps. If the head is still too large it may be crushed by the use of the cephalotribe or the bones of the vault may be removed with the cranioclast. Traction by either of these instruments will complete the delivery of the head.

Winter's three-bladed cranioclast and cephalotribe has combined the functions of the earlier instruments. This instrument is composed of three parts, one of which is furnished with a sharpened point, and carries the pin of the French lock to which the other two blades are fitted (Fig. 205). The other two blades have a small head curve and serve as the crushing blades. A screw and pinion are hinged to the central blade and can be made to operate upon each crushing blade in turn. Two slotted metal strips are hinged to

the handle of the central blade and serve to lock the crushing blades tightly when screwed up to the utmost. Then the blades are held firmly together when the crushing is complete. Finally the instrument is used as a tractor to deliver the head.
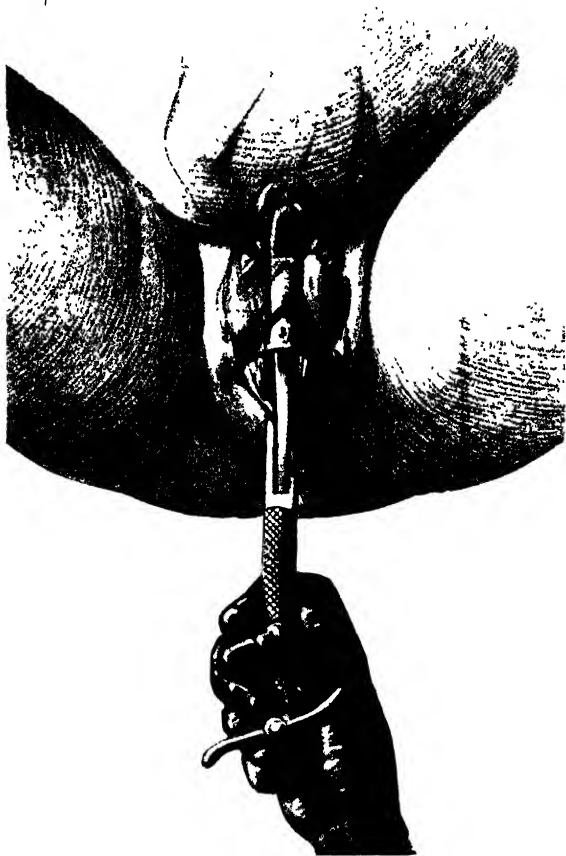
FIG. 206. Delivery of the child with the cranioclast.

Showing one blade inside the fœtal skull and the other outside. The left hand of the operator would be inside the vagina to prevent laceration of its walls by sharp edges of bone.

If the combined cranioclast and cephalotribe is not used the ordinary cranioclast is employed. For traction the fenestrated blade is passed outside the scalp, over the frontal or occipital bone. The solid blade is then passed through the perforation into the cranial cavity, so that the bone and scalp

are between the blades. The head being firmly gripped is then gently extracted.

When this instrument is used in the operation of cranioclasm the solid blade is passed into the interior of the skull through the perforation hole, and the fenestrated blade between the scalp and the bone. The handles are then tightly screwed up, the cranioclast twisted, and when the piece of bone is loosened it is withdrawn in the left hand of the operator so protecting the vagina from any sharp pieces of bone.

Whichever method of delivering the head of the child is employed it occasionally happens, especially when the pelvis is markedly contracted or the child is beyond the normal size, that further difficulty is encountered with the body of the child. In this case the arms may be brought down and used as an additional means of traction, or the blunt hook may be passed under one or other axilla of the child for the same purpose. The breadth of the shoulders may also be lessened by dividing the clavicles (cleidotomy).

Perforation in face presentation and of the after-coming head. If it is necessary to perform craniotomy and the face is presenting, the perforator should be pushed into the cranial cavity through the orbit, care being taken to push towards the mid-line.

If it is necessary to perforate the after-coming head the perforator should be pushed into the cranial cavity through the occipital bone, the legs of the child being pulled forwards or backwards as the case may be; the head will thereby be fixed, and the body being held out of the way the perforator can more easily be introduced. After the head has been perforated it can be delivered very easily by traction on the legs. In rare cases it may be necessary to use the craniotomy forceps or cephalotribe to effect extraction.

DECAPITATION

The operation of decapitation is that of severing the neck of the dead fœtus while it is still *in utero*.

Indications

(1) In impacted shoulder presentations.
(2) In certain cases of locked twins when disengagement is not possible.
(3) Very rarely in certain case of double monsters.

Technique. The preparation for the operation is the same as that described for delivery by the forceps. The patient should be in the lithotomy position under anæsthesia. The operation can be performed with:
(1) Blond-Heidler thimble and saw.
(2) Decapitating hook.

(3) In an emergency it can be accomplished with a strong pair of blunt ended long scissors.

It is just as important in this operation as in any other to examine the patient carefully to make out the exact state of affairs and the position of the fœtal parts.

Blond-Heidler thimble and saw. This instrument first described in 1923 is ingenious, safe and very effective in beheading the dead fœtus in an impacted shoulder presentation. It consists of a wire saw with a protective
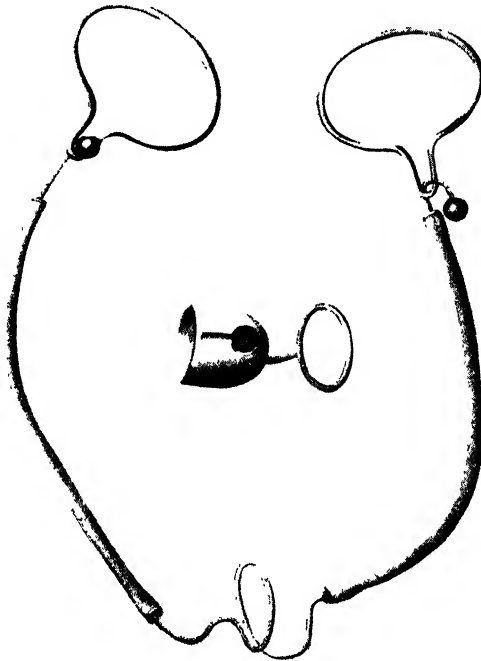
FIG. 207.   Blond-Heidler wire saw and thimble.

This essentially consists of a wire saw covered by rubber except for a few inches at its centre. A loop-type steel wire traction handle slips on to each end for sawing. The other part of it is a thimble slotted on the side to carry one end of the saw and bearing a loop on its summit.

covering everywhere other than near its middle where the cutting is to be done. At each free end there is a large metal bead that fits into a slot in the metal grip which is attached to the saw after it has been passed round the neck of the fœtus.

In order to apply the saw to the neck there is a metal thimble that fits on the thumb of the introducing hand. The thimble has a linked ring attached

FIG. 208. Introducing the Blond-Heidler saw.

The thimble is worn on the thumb of the hand introducing the saw and is readily transferred to the middle finger of the same hand curving over the fœtal neck and slipping into the loop on the thimble. The thimble carrying the saw is thus transferred from the operator's digit in front of the neck to his digit behind it.
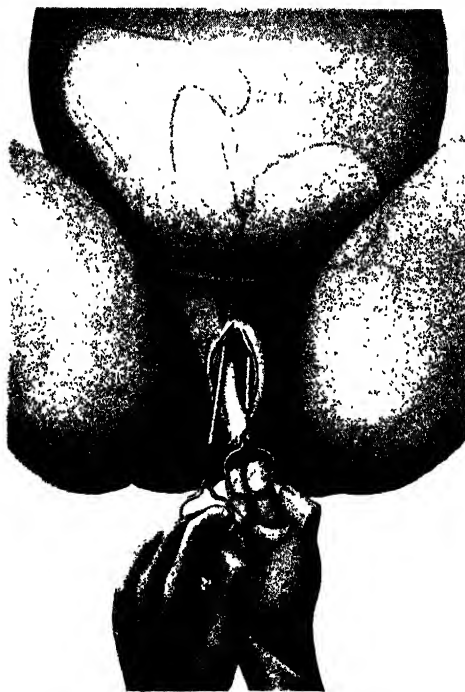
FIG. 209. Blond-Heidler saw in position.

When the operator's hand is withdrawn the saw glides up over the neck of the fœtus and sawing can begin.

to its dome into which the operator's middle finger curving round the neck will be inserted to disengage the thimble from the thumb and draw it with the attached saw over the neck and out of the vagina. The thimble has a slot for receiving the metal bead on the end of the saw. When the saw has been applied the metal handles are attached to each end. With short to and fro sawing movements the neck is severed very quickly and easily and with the minimum of intra-uterine disturbance.
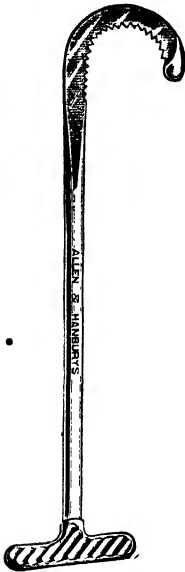
FIG. 210. Targett's decapitating hook.

FIG. 211. Ramsbottom's sharp hook. It is held and introduced in the manner shown.

Decapitating hook. This is a wide hook with a blunt end, a sharp cutting or serrated inner edge and a long handle. The handle of the hook is held in the right hand and the instrument introduced with the hook cupped in the protecting fingers of the left hand, the hook at this stage lying parallel to the neck. It is passed up between the thorax and the anterior pelvic wall to just above the neck. It is then rotated in its long axis through a right angle to carry its cutting edge over the neck. The fingers of the operator's left hand are next passed round to the other side of the neck to confirm a correct application and remain there protecting the maternal tissues from possible trauma from the blunt end of the hook. To and fro movements of the handle combined with traction sever the neck.

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Delivery of trunk and head. After the neck of the fœtus has been divided the body is easily delivered by pulling on the prolapsed arm. The decapitated head is finally delivered spontaneously, or failing this by the forceps or by the fingers inserted in the mouth. If the pelvis is contracted great difficulty may be experienced in delivering the head, in which case it may be necessary to use the cephalotribe or cranioclast.

Difficulties and dangers. The chief difficulty is in finding adequate room and the chief danger is damage to the maternal tissues. The left hand should always shield the soft-tissues from the instrument when introducing it and cutting.

Decapitation is attended by a high maternal mortality usually due to the neglected state of the case. A careful pelvic examination should always be made after delivery to detect and treat any serious damage that may have been inflicted.

CLEIDOTOMY

Indication. The birth of the shoulders is sometimes delayed owing to their abnormal size, especially in very large babies and postmature anencephalic monsters. Other methods of delivery having failed, it may be necessary to divide the clavicles.

Operation. The operator places the finger of the left hand on the clavicle of the child, and thus guided divides the clavicle with a strong pair of scissors. The body is afterwards delivered by traction on the head or feet.

SYMPHYSIOTOMY

This operation was first used by Sigault in Paris in 1777 in cases of obstructed labour due to pelvic contraction. With the advent of Cæsarean section the operation became almost obsolete.

In comparatively recent years it has been revived to some extent, particularly in Dublin, on the thesis that a uterus with a Cæsarean section scar is forever potentially weak. On the other hand it is argued symphysiotomy is a minor operation, the pelvis is permanently enlarged and the uterus remains intact.

Now that antibiotic cover is available infection is only a rare complication. The disadvantages of the operation are that the pelvic girdle is sometimes rendered unstable and permanently uncomfortable; stress incontinence is a common complication, although it is not necessarily permanent.

The indications for symphysiotomy as pronounced by the Dublin school are wide and varied and are not accepted by the majority of obstetricians. In the main it may be said that symphysiotomy could be expected to be successful in cases of cephalo-pelvic disproportion of medium degree at any

pelvic level. For disproportion at the brim this would mean a patient who had been selected for trial labour when the addition of just a little more room would result in a successful vaginal delivery. Disproportion in the cavity or outlet giving rise to delay in labour would be discovered during the careful vaginal assessment of the cause for delay and a decision reached as to whether or not symphysiotomy would give the additional room needed.

In Dublin the operation is not uncommonly done for disproportion at the brim either before labour begins or during the first stage when it has been decided that the operation will certainly be required (medium to major disproportion) and labour allowed to continue; but in cases of delay in the cavity or outlet the operation is more usual in the second stage and forceps delivery may follow.

Technique. The preliminaries are the same as for any vaginal operation. General anæsthesia is usually employed although local infiltration is satisfactory. The patient is in the lithotomy position with legs supported. It used to be thought that an assistant supporting each lower limb was essential to prevent the pelvis from springing apart when the symphysis was divided but this is not necessary. The bladder is emptied by catheter.

A vertical incision is made about 2 to 3 in. long centred over the top of the symphysis and at the spot where palpation suggests the joint lies. The incision is deepened to expose the symphysis and about the lowest inch of the rectus sheath which is now carefully incised to allow the passage of the index finger. The finger is passed down behind the symphysis pushing the bladder back, as far as the arcuate ligament. Some time may be spent in locating the joint space for it tends to be on a crest rather than in a hollow. When it is found, using a solid bladed scalpel, and with the finger always behind and below it, with careful strokes the cartilage is divided forwards and from above downwards. When the arcuate ligament is cut through in the depths of the wound the joint suddenly opens enough to admit two fingers.

Bleeding is not often a problem; it can usually be controlled by gauze packing until delivery is complete. If it continues and the bleeding point cannot be seen the packing should be left in for 24 hours under antibiotic cover.

The wound is closed after injecting 200,000 units of penicillin into the joint cavity, a dressing is applied and a many tailed binder used to support the pelvis.

A catheter should always be passed to detect hæmaturia which would suggest vesical or urethral injury. No special nursing is needed but the pelvic binder is worn for a week and the patient allowed up on the 10th day.

Full painless locomotion may be expected in 4 weeks but heavy weights should not be carried for 3 months.

EPISIOTOMY

This means a deliberate incision in the perineum to enlarge the introitus. Although it is a minor operation it increases the safety of many obstetric procedures, and a timely episiotomy can reduce the duration of labour.

The indications for episiotomy are:

1. Whenever the perineum threatens to tear.
2. After previous complete perineal tears or colporrhaphy operations.
3. Delay in delivery when the head is pressing on the perineum.
4. For forceps delivery.   .
5. For breech delivery.
6. To expedite delivery if there is fœtal distress or prolapse of the cord.
7. In cases of premature labour.

Whenever the perineum is about to tear. It is thus very commonly indicated in primiparæ when the head is about to crown and in multiparæ when the perineum has been well sutured at a preceding delivery. An escape of blood from the introitus is often an indication that the vaginal wall is tearing, even if the perineal skin is still intact. Occasionally the perineum begins to split in the centre. An incision is even more urgently needed in these circumstances.

Delivery with the occiput in the posterior position. When the occiput has rotated posteriorly and progress is good, spontaneous delivery can be anticipated; indeed the fact that it is posterior is by no means always recognized up to this stage. A suspicious sign is an exaggerated degree of gaping of the anus. The reason is that the wide bi-parietal diameter, being posterior, is over-distending the peri-anal structures. Episiotomy is particularly indicated in such cases for the twofold purpose of reducing cranial stress and the serious risk of major perineal rupture.

Outlet contraction. This is most commonly seen in the android type of pelvis in which the subpubic angle is reduced. When there is enough room in the sagittal diameter the head retreats from the symphysis in order to escape but in doing so of necessity causes increased tension in the perineum; a generous relieving incision is essential.

Previous complete perineal tear repair, or colporrhaphy. The indication is to avoid uncontrolled laceration of the perineum through the old scar.

Forceps deliveries. The commonest obstetric operation for which episiotomy is indicated is forceps delivery in a primipara, but it is by no means always necessary, expecially if the light Wrigley's forceps is used. It may be indicated before the introduction of a hand into the vagina for the purpose either of examination to discover the cause of delay or of rotating an occipito-posterior presentation.

Breech delivery. The time to perform episiotomy is when the breech is fully distending the perineum. The special indications are (i) to avoid the

commonest cause of intracranial hæmorrhage in breech delivery—cranial stress at the pelvic floor and vulval ring, (ii) to anticipate and make easier the bringing down of extended arms, (iii) to avoid causing a complete perineal tear, and (iv) to avoid the need for the breech with extended legs to flex over the perineum, and thus to facilitate delivery.

Fœtal distress. Episiotomy can be life-saving when the fœtal distress threatens at the perineal stage of delivery. The cause in this case is probably
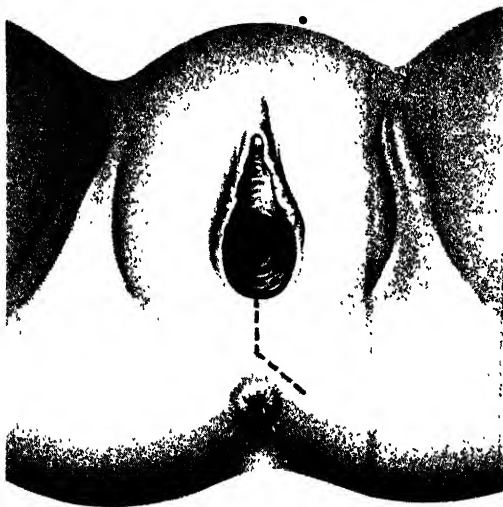
Fig. 212.   Epistomy.

that the cord is becoming increasingly tight round the neck; loss of a fœtus at this stage is an avoidable tragedy. In all cases of forceps delivery for established fœtal distress it is usually best to incise the perineum in the interest of the fœtus.

Prolapse of cord. When the cord prolapses with late rupture of the membranes in the second stage of labour, and especially if the patient is a multipara, the head will often be showing at the time the complication is discovered. By encouraging the patient to push and by incising the perineum at the appropriate moment, extra stress can be avoided and the fœtus delivered, often long before the requisite facilities for forceps delivery are at hand.

Premature labour. Epistiotomy should be a routine prophylactic measure in cases of premature labour to avoid cranial stress to which the soft, relatively large head of the premature fœtus is so susceptible.

Technique. The operation varies in its scope from an incision less than an inch long to one extending for the whole length of the perineum and beyond, but swinging to one side to clear the anal sphincter. Different forms of episiotomy have been described, median, lateral, bilateral and obliquely lateral, or medio-lateral, but these all have serious disadvantages and should not be used.

The most favoured type of episiotomy is the median. The incision should keep to the mid-line for the tissues heal so much better here than when the incision is placed laterally, there is less bleeding, and suturing being easier, is more precise. The lateral, or medio-lateral episiotomy, has disadvantages when matched against the median; healing is not nearly so favourable, there is more bleeding and suturing is more difficult.

. *Anæsthesia.* The operation may be done under general anæsthesia which may already be in use for forceps delivery; or pudendal block may have been instituted. It is sometimes done under gas and air, or trilene and air, but if local anæsthesia can possibly be used it is best. Local infiltration with 10 ml. of xylocaine (1 per cent) is employed.

The incision is best made at the height of a contraction when the presenting part is fully distending the perineum. If a knife is used two fingers are passed into the vagina between the presenting part and the perineum to protect the former. If scissors are used it should be the blunt pointed instrument, one blade being inserted on the flat between the presenting part and the posterior vaginal wall, and the other being outside. The tissues between the skin of the perineum and the lower posterior vaginal wall are incised; the structures being, firstly the decussating fibres of the bulbo-cavernous muscles, the perineal body, a fibro-muscular condensation from the above muscles, and the transversus perinei muscles. The external sphincter ani may be exposed but not cut; if the episiotomy needs to be extended the incision should curve out laterally to be outside the line of the sphincter ani bundle. It is important constantly to watch for this incision extending by tear towards the anus during delivery.

Suturing is best done when the third stage has been completed, bleeding points being clipped with hæmostats or ligated with fine catgut in the interval if need be.

The incision is closed with interrupted sutures of 2/o plain catgut throughout on a curved round-bodied needle. First the vaginal epithelium is closed from above downwards to the hymeneal ring; then the bulbo-cavernosus muscles and perineal body with one deep suture in each. Finally, the perineal skin is sutured using a curved cutting needle.

None of the sutures should be tied too tightly, for the subsequent œdema may cause strangulation and necrosis of tissue, including the skin. A sterile pad is applied. The wound is gently swabbed with antiseptic lotion and a fresh pad is applied after each use of the bed-pan.

CÆSAREAN SECTION

CÆSAREAN section is an operation by means of which the fœtus is delivered through an incision in the pregnant uterus after the beginning of the 28th week of pregnancy.

Historical note. The origin of the operation is uncertain, but it is known to be of great antiquity. References are made to it in ancient Rabbinical writings of about 140 B.C., yet it is known to have been practised on the dead pregnant woman long before this. The second King of Rome, Numa Pompilius (762–715 B.C.), through a law known as the *Lex Regia* forbade burying a pregnant woman after death before the fœtus had been cut out. This law later, in the reign of the Cæsars, became the *Lex Cæsarea* and the present day term 'Cæsarean section', arose in this way, being first used, it seems, by James Guillimeau in 1598.

The first works on the subject began to be published in the middle of the sixteenth century, but faced with the almost unsurmountable difficulties of controlling hæmorrhage and sepsis, let alone the absence of anæsthesia, it is small wonder that the mortality remained high and even at the beginning of the nineteenth century Osiander wrote :

'It cannot be denied that of the women who undergo Cæsarean section more than two-thirds die. . . . Before, then, undertaking this procedure one should allow the patient to draw up her will and grant her time to prepare herself for death.'

Apart from difficulties in controlling hæmorrhage at the time of operation, due to the prevailing opinion that sutures could not be buried in the tissues owing to sepsis, there was the problem of the open uterine wound pouring infected lochia into the peritoneal cavity with inevitable peritonitis. Because of this there arose, early in the nineteenth century, the idea of making an incision as low as possible in the uterus or even the upper vagina to allow dependent drainage to take place; for, up to this time, the incision had been made in the upper segment. Advance was negligible, however, until the middle of the century when Simpson discovered anæsthesia, Semmelweiss found the cause of child-bed fever, and Lister introduced the use of antiseptics.

However, there was still the problem of lochia discharging into the abdomen, and it was not until 1876 that Porro of Padua temporarily solved it by following Cæsarean section with subtotal hysterectomy and marsupializing the cervical stump in the abdominal wound. The Porro operation was

a step forward, but obvious disadvantages made it short lived and it became outmoded when, in 1881 and 1882, Kehrer and then Sänger devised satisfactory methods for suturing the uterine wound in two layers, muscle and peritoneum, using silk.

The scope of Cæsarean section became enormously enlarged and obstetricians appeared to vie with one another in devising new incisions in all parts of the uterus, including the posterior wall. But although the mortality dropped impressively to 5 per cent and less, operations entailing incision of the upper segment were almost invariably fatal in cases infected before operation.

In 1906 Frank of Cologne devised an operation which not only employed transverse abdominal and lower segment incisions, but excluded the lower segment from the general peritoneal cavity. This he did by suturing the upper edge of the parietal to the upper edge of the visceral utero-vesical peritoneum. He closed the uterus in two layers with catgut. He is, moreover the first to have used Cæsarean section in the treatment of placenta prævia, although this had been suggested many years previously by Lawson Tait.

In the next few years the lower segment operation gained much popularity and became simplified by no longer being isolated from the general peritoneal cavity.

Extra-peritoneal Cæsarean section which was first devised in the early nineteenth century by Ritgen, and later used by Latzko, again became popular for the suspect and frankly infected case. Between the years 1930–40 Everard Williams in this country, Burns and later Waters in the U.S.A. published papers on it, but the operation offers little other than tedium and now has few if any advocates.

Indications

The indications for Cæsarean section today are here considered under the headings as *always* or *sometimes*.

It would be wrong to assume that the compartments are even as well defined as this, for changing circumstances will often create the need for a change in tactics, and each time Cæsarean section is considered the indications in the particular case need to be carefully studied.

The trend today is for Cæsarean section to be used much more widely than heretofore, and the rate now is just over 6 per cent. In the main this increase is closely connected with a wish to diminish the risk to the fœtus and improve its chances of survival in such conditions as placenta prævia, accidental hæmorrhage, severe pre-eclampsia, diabetes mellitus, hæmolytic disease, prolapse of the cord and abnormal uterine action. Running parallel with this is the greatly reduced risk of Cæsarean section from infection, brought about by the antibiotics. The conditions for which Cæsarean section is indicated will now be briefly considered.

Always. Even conditions mentioned under this heading will sometimes be managed differently through force of circumstances.

Any gross obstruction to delivery such as *major pelvic contraction* and *impacted pelvic tumours* need no further comment, but sometimes serious organic stenosis of the cervix or vagina is just as impassable and necessitates abdominal delivery; the rare anterior sacculation of the uterus, arising from an impacted retroverted gravid uterus is also an indication.

Placenta prævia of major degree is best treated by Cæsarean section in the interests of both mother and baby. This has been the standard treatment for some years for cases of major degree, but it is being used with encouraging results for many more cases of medium degree especially when the placenta prævia is posterior, and even for some minor degrees, when there is any other complicating factor. The extended use of Cæsarean section together with the expectant management of placenta prævia have reduced the fœtal mortality in this condition from over 40 per cent to under 10 per cent. The maternal mortality is less than 1 per cent which results from earlier diagnosis, admission to hospital and blood-transfusion.

When a properly conducted *trial labour in the previous pregnancy* has failed through real disproportion, the subsequent delivery of a mature fœtus should be by Cæsarean section. Sometimes a trial labour has to be terminated by Cæsarean section before there has been a real test because of fœtal distress, and sometimes minor disproportion has been aggravated by the presence of a large postmature fœtus, often with the occiput posterior. Commonly the test fails because of lack of progress, through abnormal uterine action. Cæsarean section would not necessarily be indicated subsequently, but each case must be separately reviewed.

It could be said that there is always an indication for Cæsarean section when a *trial labour is failing* for one reason or another, some of which have been mentioned already. When it becomes obvious that in spite of effective contractions with the membranes ruptured and the cervix partly dilated, there is still lack of progress, Cæsarean section should not be delayed.

A persistent breech presentation complicated by disproportion arising either from pelvic contraction or an over-size fœtus (in excess of 9 lb.) is an indication for Cæsarean section. The size of the fœtus is important when considering breech delivery especially in a primigravida, but unfortunately it is not always possible to recognize a big fœtus antenatally. Because primary uterine inertia is often associated with the presence of a large fœtus, it should act as a warning and call attention to the need for reassessing this aspect of the case, especially if with a breech with extended legs.

Any patient with *a disease complicating pregnancy in which the stress of normal labour must be avoided* should be delivered by Cæsarean section. Such diseases as tuberculous laryngitis, congenital cerebral aneurysm and recurrent detachment of the retina would all come under this heading. It

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will be noted that heart disease does not, unless labour is expected to be difficult.

A bad obstetric history when the patient has had several successive pregnancies with dead babies, is almost always a sufficient indication to deliver the next by Cæsarean section.

Prolapse of the cord when the cervix is not sufficiently dilated to allow immediate vaginal delivery is now treated by emergency Cæsarean section if the fœtus is alive. While preparations are being made for the operation pressure should be kept off the cord by pushing the head or breech, whichever is presenting, into the iliac fossa or continuously elevating the presenting part with the gloved hand. The patient can be given oxygen to inhale and the cord should be replaced into the vagina to keep it warm and avoid spasm of its vessels.

Progressive fœtal distress in the first stage of labour can usually only be dealt with successfully by Cæsarean section if the degree of dilatation of the cervix will not permit vaginal delivery.

Sometimes. Under this heading come some of the less certain decisions of the former group such as a bad obstetric history. With the problem of whether to deliver by Cæsarean section or not it is a useful guiding principle that a patient can usually deal successfully with one obstetric abnormality if it is not too severe, but seldom with two. A good example is heart disease; normal labour is usually managed successfully, but should be avoided if difficulty is expected. Breech presentation with the suspicion of a big fœtus, or an elderly primigravida with postmaturity, are examples of difficult situations created by two abnormalities and in such cases Cæsarean section is often indicated.

Cæsarean section is not always indicated in the case of the *elderly primigravida*, but when there is *an additional obstetric complication* such as minor disproportion, toxæmia, essential hypertension, antepartum hæmorrhage, postmaturity or persistent malpresentation, there are very good grounds for choosing Cæsarean section.

Diabetes mellitus is very often managed by delivery by Cæsarean section at 36–37 weeks, especially in a primigravida. Sometimes the induction of premature labour is preferred in the case of patients who have had a previous vaginal delivery.

Abnormal uterine action resulting in hypertonic lower segment or cervical dystocia, is now being treated much more often by Cæsarean section with decidedly improved results.

Malpresentations are sometimes treated by Cæsarean section. Breech presentation has already been mentioned, and for this the operation may be performed in any case in which difficulty is anticipated because of the size of the child or contraction of the pelvis, but also in cases in which the

mother is elderly or infertile. A *brow presentation* with the head not engaged in the pelvis is best treated by Cæsarean section; this is not necessary for the case in which a relatively small head has undergone secondary extension in the pelvic cavity. Cases of *shoulder presentation* in which external correction is not possible and the fœtus is alive are most safely treated by section. Cæsarean section is very rarely indicated for *locked twins* if one or both are alive and cannot be disengaged.

Accidental antepartum hæmorrhage, when it is concealed and extensive, kills the fœtus before anything can be done to save it; but in cases in which the hæmorrhage is not so great the fœtus may still be alive. In these cases Cæsarean section offers the only reasonable chance for the fœtus, if natural delivery is not imminent. Because hypofibrinogenæmia sometimes accompanies concealed accidental antepartum hæmorrhage the fibrinogen content of the patient's blood should be assessed before operation and made good if found deficient.

Mention has been already made of the extended use of Cæsarean section for more cases of *placenta prævia of lesser degree.* This is almost always to improve the chances of the fœtus, for the risk from cord or placental compression is always present with vaginal methods of treatment.

Fulminating pre-eclamptic toxæmia may have to be treated by Cæsarean section if the chances of early vaginal delivery are small. The patient may not be in labour, or labour after induction may be inert. If the severity of the toxæmia demands that the patient has to be delivered before the 34th week Cæsarean section may be preferable to induction, especially in the case of a primigravida.

Severe benign hypertension is a serious complication of pregnancy. Not only is pre-eclamptic toxæmia more likely to supervene but even if there is no progression of the hypertension placental insufficiency may occur. The fœtus may not grow as much as would be expected and intrauterine death may occur. It is not surprising therefore, that the uncertainty of labour is avoided by Cæsarean section in some cases, especially in older patients.

When the membranes have been ruptured artificially and labour does not begin, *failed surgical induction,* there is anxiety regarding the possibility of genital sepsis and of intra-uterine infection of the fœtus; the longer the patient remains undelivered under these conditions the more likely are these complications to supervene. If labour has not begun in 24 hours it is common practice to give antibiotics and chemotherapy (penicillin and sulphonamide) and at the same time to set up a continuous intravenous oxytocin infusion. This almost always stimulates the onset of labour, but sometimes it fails or there may be other serious considerations and Cæsarean section may have to be done. For example the age of the patient, or progressive toxæmia, may determine it, or infection may already have occurred; the latter complication is always an indication for Cæsarean

section. A persistently raised fœtal heart-rate may be the only, but significant, indication of infection in its early stages.

Finally *severe hæmolytic disease of the newly-born* may have resulted in the loss of one or more infants. When the husband is homozygous and rhesus positive all subsequent pregnancies will be severely affected, and the present tendency is to deliver the next fœtus at a time when it is mature enough to stand a chance, before irreversible damage from hæmolytic disease has taken place. This will some times necessitate delivery as early as 32 weeks, and it is often felt that Cæsarean section at this stage is a more certain and less risky form of delivery for the immature fœtus affected by hæmolytic disease than vaginal delivery after induction of labour.

Choice of operation

The standard operation of Cæsarean section today is the transperitoneal lower segment operation with a transverse incision in the uterus. It is a well-devised operation for these reasons:

1. The incision is in the thinner and less vascular part of the uterus. In most cases, therefore, hæmorrhage is slight with little damage to the uterine musculature.

2. The wound in this situation can be completely covered by the protective loose peritoneum over the lower segment. This provides a valuable safeguard against the formation of adhesions and intestinal obstruction; it adds an additional protective barrier against general peritonitis in suspect or infected cases.

3. The operation, although transperitoneal, is in a cul-de-sac and is virtually isolated from the general peritoneal cavity. This is important in avoiding post-operative ileus in clean cases and peritonitis in infected cases.

4. The relative tranquillity of the lower segment in the puerperium is thought to favour sound healing and so decrease the risk of subsequent rupture of the scar.

5. These facts suggest that the transperitoneal lower segment operation is safer than classical Cæsarean section.

Choice of time for operating. The best results are obtained from Cæsarean section when there is ample time to prepare the patient; for this reason the operator, when there is free choice, decides upon some day in the week preceding the expected date of labour. The uterus will contract and retract after the child is removed whether the patient is in labour or not. If, however, there is any uncertainty as to the duration of pregnancy, it is better to wait until labour begins before operating.

Preparation for the operation. The preparation of the patient is similar to that for any other major abdominal operation, except that a strong purgative should not be given the day before for fear of inducing labour, but an enema is given on the morning of the operation. Morphia is best avoided as premedication for the anæsthetic owing to its effect on the fœtus.

The team is the same as that for any major operation, but in addition there must be an experienced person to take care of the baby with modern resuscitation equipment at hand. If any difficulty arises in the establishment of respiration the help of a skilled anæsthetist in the care of the baby is invaluable. A catheter should be passed just before the patient is placed on the operating-table. It is essential for the welfare of the child that the patient should not be under the influence of the anæsthetic longer than is absolutely necessary before the operation is begun. All preparations, therefore, must be made before the anæsthetist commences.

If more than average blood-loss is expected cross-matched blood must be ready in the theatre; in all other cases the patient's serum should be in the laboratory so that cross-matching can be done without delay if blood is unexpectedly needed.

Sterilization. When Cæsarean section is performed for some chronic progressive disease and a decision has been authoritatively made that further pregnancy is to be avoided, sterilization after Cæsarean section is justifiable. The expert on whose second opinion the operation is being advised should give his advice in writing and sign it. The significance of the operation should be carefully explained to both the patient and her husband and both should sign consent.

Sometimes the operation is performed because the patient has a contracted pelvis and wishes to avoid further Cæsarean sections, but it is usual not to consider sterilization until she has had at least two Cæsarean sections. The operation is justified on the grounds of the increased risk of Cæsarean section over natural delivery, but its final and conclusive negation of future childbearing should be carefully explained.

In such cases when the operation is not being done on purely medical grounds, e.g. after the second Cæsarean section, it is wise to point out that babies lead a somewhat precarious existence for some time after birth, and it is not possible to guarantee that it will survive and thrive. Sterilization as a planned operation when the baby is between 6 and 12 months old is a wiser procedure.

Finally, Cæsarean section is never done merely in order to sterilize a patient. Such a procedure is never justifiable. If sterilization has been recommended for a patient with heart disease, unsuitable for cardiac surgery, the operation is best done about a week after normal delivery while the uterus is still partly an abdominal organ. It can then be very easily done

under local anæsthesia combined with sedative drugs; but breathing-exercises and leg-exercises should be encouraged after operation to lessen the risk from embolism. If local anæsthetics are being used the meso-salpinx* as well as the abdominal wall must be infiltrated.

The most certain method of tubal sterilization is excision of the inter-stital part of each Fallopian tube, but the operation is not devoid of risk from hæmorrhage.

Anæsthesia for Cæsarean section. In choosing the most suitable form of anæsthesia for Cæsarean section the effect of the drug on the fœtus must be considered as well as the practice and experience of the anæsthetist. If the latter is limited, then the anæsthetic agent with which he is most familiar should be chosen. One of the most important aspects of the technique is the maintenance of a clear airway to avoid cyanosis, and the avoidance of aspiration of gastric contents. The suggestions put forward with regard to the safeguards to be taken with inhalation anæsthesia for forceps delivery (p. 499) are just as important for Cæsarean section.

FIG. 213.   Cæsarean section incisions.
(A) Classical incision. One third of its extent is above umbilical level and the remainder below.
(B) Lower segment incision. This incision is entirely below umbilicus.

Some form of inhalation anæsthesia such as nitrous oxide and oxygen, with trilene, ether, or fluothane, is often chosen for safety. When the patient is not labour, nor is the head deep in the pelvis, such an anæsthetic can be light and the fœtus can be delivered relatively quickly before it absorbs significant amounts of anæsthetic. If on the other hand more relaxation than light anæsthesia can offer is required, either more of the volatile agent must be added with possible adverse effects on the fœtus or, better than this, regional infiltration of the abdominal wall with local anæsthetic is carried out before inhalation anæsthesia is begun.

With expert anæsthetists the most popular anæsthetic drugs are pentothal, gas and oxygen, and scoline. If relaxants are used a cuffed intratracheal tube should be inserted. There is no danger to the fœtus from pentothal, and scoline does not cross the placental barrier, but it increases uterine tone which may be a slight disadvantage when extra relaxation is needed, as in elevating a head from the pelvis,

Spinal anæsthesia is not employed so much as its theoretical advantages might suggest and has largely been replaced by extradural anæsthesia.

Local anæsthesia for Cæsarean section is ideal for the fœtus but it does not suit all patients.

Lower Segment Operation

The peritoneal cavity is opened by a vertical incision from the umbilicus to just above the symphysis pubis. A hand is passed into the peritoneal cavity to confirm that the uterus is not unduly dextro-rotated. A long gauze roll moistened in saline is tucked in between the uterus and the parietal
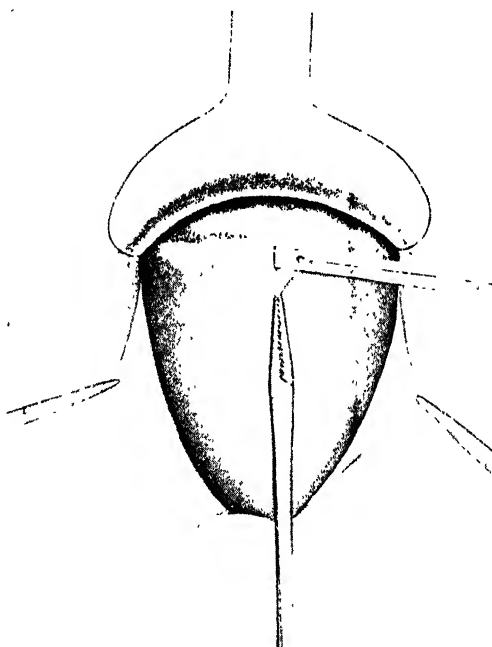
FIG. 214.   Lower segment Cæsarean section.

The loose peritoneum over the lower segment is being lifted up before it is incised.

peritoneum around the operative field to prevent unnecessary spilling of blood and liquor. One end of the roll is left out of the wound with an artery forceps attached. A Doyen's retractor is inserted into the lower end of the wound. The peritoneum of the utero-vesical pouch is divided transversely near its upper limit for about $3\frac{1}{2}$ in., and the bladder is gently pushed down.

FIG. 215.   Lower segment Cæsarean section.
The lower segment is being exposed and a short incision made through it down to the membranes.
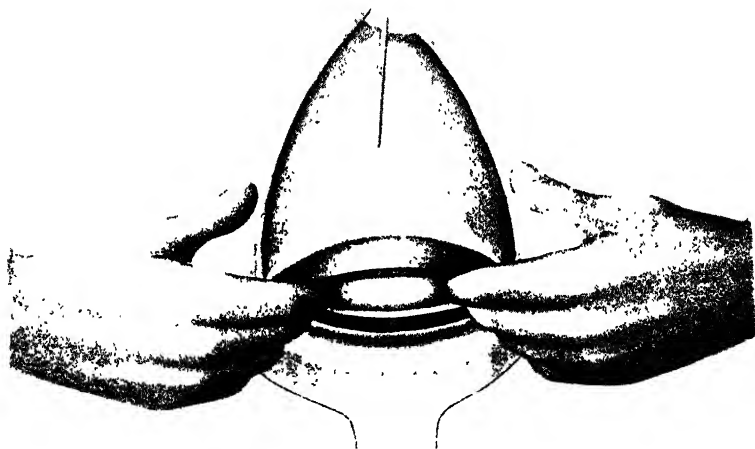
FIG. 216.   Lower segment Cæsarean section.
The incision in the lower segment is being enlarged by finger traction.

(a)

(b)

(c)
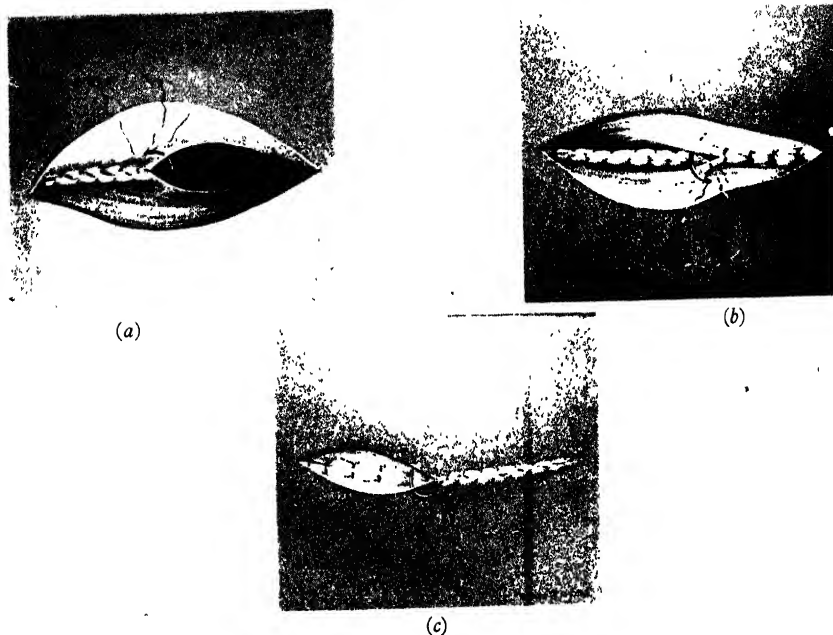
FIG. 217. Lower segment Cæsarean section.

(a) Inserting the continuous deciduo-muscular catgut suture.
(b) Inserting the interrupted musculo-fascial catgut suture.
(c) Inserting the continuous peritoneal catgut suture.

(a)

(b)

(c)
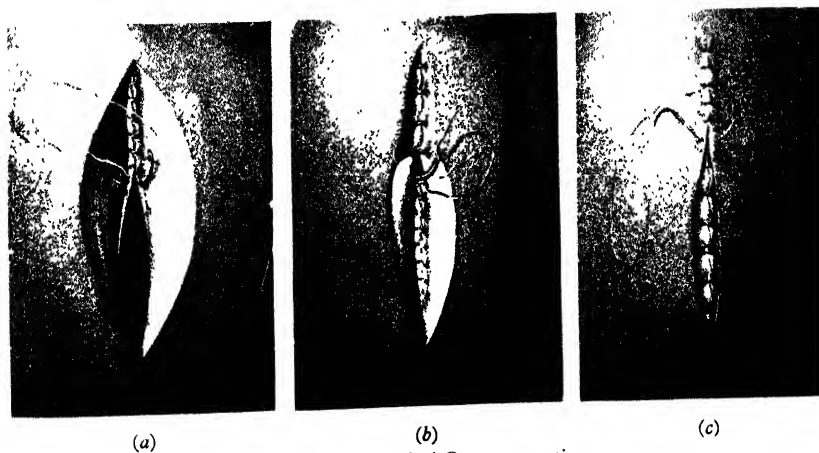
FIG. 218. Classical Cæsarean section.

(a) Inserting the continuous deciduo-muscular catgut suture.
(b) Inserting the interrupted non-absorbable muscular suture.
(c) Inserting the continuous peritoneal catgut suture.

The retractor is now slipped behind the bladder and loose flap of peritoneum to hold them forwards and expose the lower segment. A transverse incision about 1 inch long is made in the mid-line of the lower segment and deepened until the membranes bulge, but the amniotic sac, if possible, should be kept intact at this stage. Two index fingers are slipped into the incision by which it is split transversely to an extent of about $3\frac{1}{2}$ in. The membranes are ruptured and the head is delivered by slipping a hand beneath it and applying first one blade of Wrigley's forceps and then the
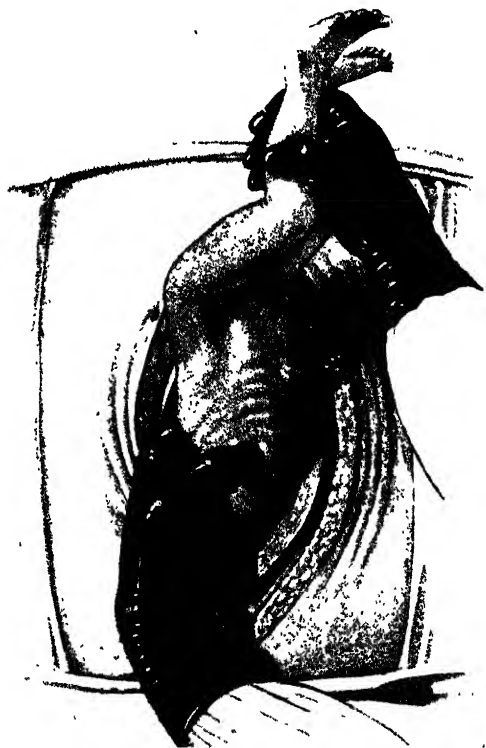
FIG. 219.   Classical Cæsarean section.
Delivering the child.

other. The head should always be delivered gently; if the patient is in strong labour and the head is deep in the pelvis or wedged in the brim, some help can be gained by the table being given some degrees of Trendelenberg tilt. Very occasionally an assistant may be needed to push the head up from below. As the head is delivered the anæsthetist injects 0·5 mg. of ergometrine into a convenient vein of the patient's hand or arm, sometimes combined with morphia. The shoulders are carefully delivered, being

eased out of the wound to avoid dangerous splitting of the lateral extremities of the wound. The fœtus is held head downwards to drain it of liquor; the mouth and pharynx are cleared with the finger. The cord is clamped and divided and the infant is handed over to the care of an assistant.

The placenta soon separates and it is delivered through the wound. The uterus is explored to confirm the complete expulsion of the placenta and a finger is passed down through the cervix for drainage.

The uterine incision is sutured in layers, the suture material varying according to the idiosyncrasy of the surgeon. The abdomen is closed in usual way.

Classical Cæsarean section

The incision in the abdominal wall should be made either to one side of the mid-line or in the mid-line, is about 6 inches long, and is placed so that one-third is above the level of the umbilicus and two-thirds below. After the peritoneal cavity has been opened a hand is introduced to cant the uterus back evenly from its dextro-rotated position. The uterus is incised vertically in the mid-line of the anterior wall of the upper uterine segment, the membranes are ruptured and the fœtus is then delivered through the wound.

The incision in the uterus is sutured with two layers of catgut and the abdomen is closed in the ordinary way.

Post-operative care. The patient who has had a Cæsarean section is looked after in the same way as any patient who has had a major abdominal operation.

The dangers of Cæsarean section

These can be best discussed under the headings immediate and remote, but closely concerned with both will be the circumstances of the operation, the reason for the operation, the fitness of the patient before and during labour, previous attempts at delivery, the skill of the operator and anæsthetist and finally the type of operation.

The risks in lower segment Cæsarean section performed as a planned operation under good conditions by a competent operator aided by a skilful anæsthetist, are very low as a major operative procedure, being approximately 0·3 per cent.

Immediate. The risks entailed include only those during the operation and the immediate post-operative interval.

Blood transfusion must always be readily available for patients undergoing Cæsarean section particularly for cases of placenta prævia.

Sufficient emphasis has already been given to the importance of an operating-table which can rapidly be tilted in order to avoid the inhalation

of gastric contents. Infection in the planned operation has been reduced to negligible figures, and serious postoperative ileus is now rare.

Pulmonary embolism occasionally occurs after Cæsarean section, more particularly in obese and anæmic patients. Anticoagulant therapy undoubtedly has played a part in the more effective management of these cases, but treatment of anæmia in pregnancy could be even more valuable prophylactically. When Cæsarean section is contemplated in an emergency, anæmia and shock should be treated first by blood transfusion.

Remote. Two dangers fall into this category; (i) Intestinal obstruction, (ii) Rupture of the uterine scar. Now that the lower segment operation is the standard procedure intestinal obstruction is rare. But it may occur in a subsequent pregnancy owing to the stretching of adhesions by the enlarging uterus.

Rupture of the scar is relatively a rare complication in a subsequent pregnancy or labour. The classical Cæsarean section scar is more likely to rupture than the lower segment one. Infection makes rupture much more likely after either operation. But whether infected or not any patient who has had a Cæsarean section should be under the care of an obstetrician and be in hospital for all subsequent deliveries.

Dangers to the fœtus. The operation carries little risk for tne fœtus. Nevertheless, Cæsarean section has an inherent very small hazard. (i) The operation requires an anæsthetic, and if this is something other than local the fœtus may suffer from anoxia if any difficulty arises. Respiratory difficulty may occur with the premature infant especially in diabetes; hyaline membrane disease is not an uncommon finding. Sometimes when Cæsarean section is planned near term the expected date of delivery may not be correct and the operation is erroneously done at the 35th rather than the 39th week. For this reason some obstetricians operate only after the onset of labour. (ii) It is possible to cause serious intracranial damage by delivering the head without proper care either up from the pelvis or through too small a uterine incision. It is therefore unwise to promise the birth of a living thriving baby by Cæsarean section even when carried out as a planned operation.

Cæsarean hysterectomy

This operation is rarely indicated, although it carries very little additional risk.

The indications may arise from such conditions as:

(1) Fibroids. When the patient's age and wishes are against further pregnancies multiple or interstitial fibroids are best treated by hysterectomy.

(2) Uncontrollable hæmorrhage through either operative trauma or uterine atony. These complications have been already discussed. In cases of concealed, or largely concealed, accidental hæmorrhage serious bleeding may occur from the abdominal wound as well as from the uterus. In such circumstances it may well be due to hypofibrinogenæmia when fibrinogen replacement is indicated rather than hysterectomy.

(3) Sepsis. It is doubtful if hysterectomy is ever more than occasionally justifiable for severe infection now that antibacterial control is so effective.

(4) Placenta accreta may have to be treated by Cæsarean hysterectomy. It is certainly best if the condition is more than of minimal degree and the woman parous.

(5) Rupture of the uterus. Hysterectomy may be indicated after rupture of the uterus if there is serious infection or if the rupture is so extensive that repair is either not practical or would leave a dangerously weak scar.

(6) Previous Cæsarean sections. This indication seldom arises, but if sterilization is the alternative, hysterectomy may be preferred.

(7) Malignant disease. This may be ovarian when removal of the uterus and both ovaries is indicated; or it may be carcinoma of the cervix, when Wertheim's hysterectomy is the correct operative procedure.

Technique. This differs little from the standard procedure on the non-postpartum case except that the tissues, especially the connective tissue, are softer and more plastic. The steps of the operation are exactly the same but when the patient has been in labour for some time the cervix and vagina may be indistinguishable from one another. The fingers can if necessary be passed through the lower segment wound to help delineate the boundaries.

THE THERAPEUTIC TERMINATION OF PREGNANCY

PREGNANCY may be terminated:

    1. Before the child is viable, induction of abortion.

    2. When the child is viable, induction of labour.

INDUCTION OF ABORTION

·In Britain the Offences Against the Person Act, 1861, says 'whosoever shall *unlawfully* use an instrument or administer any noxious thing with intent to procure abortion shall be guilty of felony, and being convicted thereof shall be liable, at the Discretion of the Court, to be kept in Penal Servitude for life or any Term not less than Three Years. . . .' The law specifically states that attempts to induce abortion, even if the woman is eventually shown not to be pregnant, are regarded as being in precisely the same category as if she were with child. Furthermore, the attempted induction of abortion by the administration of drugs is legally regarded in the same light as when surgical means are employed.

The crux of the matter is the interpretation of the word 'unlawfully'. It has long been accepted as lawful to procure abortion to save the life of the mother; since Rex *v.* Bourne, 1939, it has also been accepted as lawful to terminate pregnancy if its continuation means that the patient's physical or mental health will suffer.

As the immediate or prospective danger to the mother cannot be accurately estimated, many cases will occur in which a correct judgement is difficult. It is incumbent on every medical practitioner to obtain another opinion, preferably from a consultant who has specialized in the condition under consideration, for his own protection, since he may have to meet the suspicion of illegal abortion. The induction of abortion should never be carried out by a general practitioner, the operation should only be done in hospital by a consultant.

The pressure on the doctor may become so strong that he may be persuaded to perform an abortion against his better judgement, and before he is convinced that all other measures have failed. For instance, in a severe case of vomiting of pregnancy, although the patient's urine is normal, her pulse-rate scarcely raised, her tongue moist, and there is no evidence of loss of weight, both she and her relatives may insist that pregnancy must be terminated or she will die. Moreover in many cases the patient, for

economic or other reasons, is desirous of having her pregnancy terminated. The question must be settled on purely medical grounds, and every effort must be made to check the patient's story by observation, for she may exaggerate every symptom, and produce new ones if the old ones fail to give the looked-for result.

Some practitioners are ready to forbid a woman to have any more children because something went wrong during a former pregnancy or labour, and to recommend the induction of abortion, even repeatedly, if pregnancy occurs. Such advice should almost never be given.

Should it be decided that the pregnancy is to be terminated the written consent of both the wife and her husband must be obtained. If the mother is a minor and unmarried both her parents should give written consent.

Indications

Some of the indications for the operation are discussed below:

Hyperemesis gravidarum. With few exceptions this complication can be arrested with early and adequate treatment in hospital. In very rare cases if, in spite of correct treatment, the patient's condition deteriorates as evidenced by the appearance of jaundice, termination of the pregnancy is urgently indicated.

Cardiac disease. With the recent advances in cardiac surgery termination of pregnancy for mitral stenosis (and for congenital cardiac lesions) is becoming less frequent. Termination and mitral valvotomy must be considered as alternatives in patients in class III or IV with advanced disease, who have had attacks of heart failure before pregnancy, or heart failure with pulmonary venous congestion early in pregnancy.

In congenital heart disease patients without cyanosis tolerate pregnancy well, but if cyanosis is easily produced termination or surgery must be considered.

Termination of the pregnancy should be done vaginally (see below) before the 12th week of pregnancy. The risk of abdominal hysterotomy is usually greater than the risk of continuation of the pregnancy.

Pulmonary tuberculosis. Pregnancy has little effect on the course of pulmonary tuberculosis provided that there is adequate supervision and treatment throughout pregnancy, labour and the puerperium. This calls for the closest co-operation between the physician, the obstetrician and the local health authority, so that the patient may be provided with adequate help and continuity of treatment and supervision on her return home.

Termination of pregnancy is now rarely done in these cases except for patients with lesions which have recently become quiescent under treatment.

Chronic nephritis. The patient with severe chronic nephritis has such a small chance of having a live baby that termination of the pregnancy may

be considered in cases with hypertension, increasing albuminuria or œdema, retinal changes or impaired renal function. In such cases it is unwise to risk possible further deterioration when the chance of a live child is small.

Mental illness. Termination of pregnancy on the grounds of mental illness is one of the most difficult problems in obstetric practice. While there are unquestionably psychiatric illnesses which justify termination, it must always be remembered that any woman, pregnant against her wish, is under very great mental strain and is often prepared to go to any lengths to get rid of the pregnancy. Her position is frequently made worse by her social circumstances in that she may be unmarried. Her genuine distress may closely simulate or actually precipitate psychiatric illness and threats of suicide are not uncommon.

The opinion of a reputable psychiatric consultant must always be obtained, in writing, before considering the induction of abortion.

Rubella. There is no doubt that rubella in pregnancy may cause congenital defects of the fœtus. These defects include cataract, congenital heart disease, deafness and microcephaly, but they only occur when the infection occurs in the first 12 weeks of pregnancy. There is an increased risk of abortion, stillbirth and death of the child in the first year of life, with a 25 per cent risk of a severe congenital deformity in those who survive to the age of 2 years.

It is hardly surprising, therefore, that the woman who contracts rubella in pregnancy will be most concerned about the possible effects that it may have on the unborn child and it is likely that she will request that the pregnancy should be terminated.

This is a very difficult problem since the risk of a malformed child cannot be accurately assessed; it is known to vary in different epidemics, the estimates ranging from 20 to 60 per cent with infection in the first 12 weeks. After that the risk is so small that it can be ignored.

Pregnant women should avoid any possible contact with rubella, but if this should happen then 15 ml. of a γ-globulin preparation from the serum of convalescent patients should be given. This may confer some immunity if injected within 8 days of contact, but if the mother acquires rubella the globulin will not protect the fœtus.

If a pregnant woman should get rubella within the first 12 weeks and the diagnosis can be confirmed by reliable clinical observations then termination may have to be considered.

A similar problem may arise in relation to major developmental abnormalities which are certainly known to be transmitted as a Mendelian dominant trait.

It should be remembered that the general incidence of congenital malformations is about 2 per cent of all births, and that only about 25 per cent of congenitally malformed children will be seriously incapacitated by their

particular defect. There is no general consensus of opinion on the desirability of termination of pregnancy in these circumstances since there are so many unknown factors, and it is not legal to terminate a pregnancy merely to avoid a deformed child. If termination be considered, it is necessary to show that worry about the probable abnormality of the unborn child is adversely affecting the health of the mother.

Methods

The method to be employed will depend on the nature of the disease for which the abortion is being induced, and the date to which the pregnancy has advanced.

1. Dilatation of the cervix and evacuation of the uterus *per vaginam*.
2. Injection of hypertonic saline into the amniotic cavity.
3. Abdominal hysterotomy.

Dilatation of the cervix. This is the best method of emptying the uterus rapidly, provided that it is done earlier than the 12th week.

Operation. The patient is anæsthetized and placed in the lithotomy position. The vagina is then swabbed with antiseptic solution after which a weighted speculum is inserted and the cervix is pulled down by a volsellum.

The cervical canal is carefully dilated. The tip of each dilator need not be passed far into the cavity of the uterus; it should be passed so that it just dilates the internal os. If this is done the amount of separation of the ovum from the uterine wall produced by the introduction of each successive dilator will be enormously decreased, and as a result the bleeding during this stage of the operation will be negligible. Dilatation is continued up to No. 16 dilator. A ring or ovum forceps is then passed gently through the cervix. As soon as the instrument is inside the cavity of the uterus, it is slowly opened to its full extent, and then slowly closed. Withdrawal must be slow and gentle. During the operation 0·5 mg. of ergometrine is injected intravenously by the anæsthetist and within a few minutes the bleeding will stop. Persistent bleeding generally indicates that some portion of the ovum still remains in the uterus, and calls for further exploration of the uterine cavity.

It is important to appreciate that this operation is full of dangers, and that unless the operator is expert and uses the greatest care he can quite easily perforate the uterus or infect the patient. Hæmorrhage is often very considerable and it may occasionally be necessary to pack the uterine cavity with ribbon gauze and give a blood-transfusion.

After the end of the 12th week of pregnancy, if the cervix is closed, it is a matter of very considerable difficulty immediately to empty the uterus by the vaginal route. At this period of pregnancy the head of the child is of

such a size that it is only rarely that the cervix can be dilated to a degree which will allows of its easy extraction. It is probable that the cervix will be dangerously lacerated in the region of the internal os in attempts to dilate" it sufficiently, or else the head of the fœtus will become detached from its body. Severe hæmorrhage may accompany this procedure.
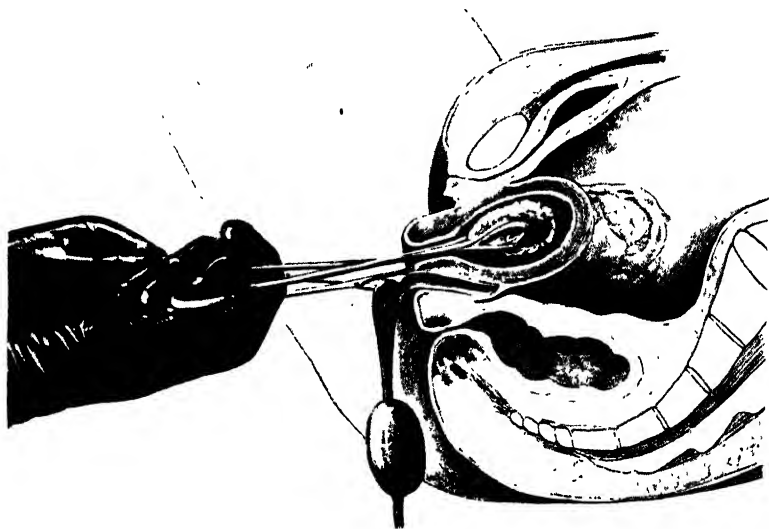
FIG. 220.   Removal of the detached ovum with ovum forceps.

Injection of hypertonic saline. In those cases in which termination of pregnancy is indicated after the 12th week of pregnancy it is usually possible to induce an abortion by inserting a needle through the abdominal wall or vaginal fornix into the amniotic cavity, by aspirating as much liquor as possible and replacing it with a 20 per cent saline solution. Abortion usually occurs within 36 hours.

Serious uterine infection has occurred in a few cases in which hypertonic glucose solution was used for this purpose, and anuria has occurred in a case in which the uterus was wrongly and grossly overdistended with fluid.

Abdominal hysterotomy. This operation, consisting of a miniature classical Cæsarean section, can be done at any stage of pregnancy, and sterilization can be performed at the same time, if indicated.

The abdomen is opened by a midline subumbilical incision. The uterus is lifted up through the incision and the rest of the peritoneal cavity excluded from the operation area by one or two large abdominal packs. At this stage ergometrine, 0·25 mg., should be injected directly into the uterine muscle to diminish the amount of bleeding. A vertical incision is now made

in the anterior surface of the body of the uterus through the whole thickness of the muscle, and the fœtus, placenta and membranes are removed; if the pregnancy is in an early stage it is generally possible to deliver the gestation sac and placenta intact through the incision after gentle separation with a finger.

If sterilization is indicated, it can be performed by ligature or excision of the Fallopian tubes before the abdomen is closed.

INDUCTION OF LABOUR

Indications

Labour is induced in some cases of :
1. Pre-eclamptic toxæmia.
2. Postmaturity.
3. Cephalo-pelvic disproportion.
4. Antepartum hæmorrhage.
5. Hydramnios.
6. Diabetes.
7. Hæmolytic disease.
8. Intrauterine fœtal death.
9. Breech presentation.

The list given above contains the commonest indications for the induction of labour, but in special circumstances it is employed in a large number of other conditions.

Toxæmia of pregnancy. This is the commonest indication for the induction of premature labour.

Postmaturity. If it is certain that a pregnancy has been prolonged to the 42nd week it is generally considered advisable, in the interest of the fœtus, that labour should be induced, particularly if the patient has hypertension or is over 35 years old.

Disproportion. Trial of labour is the method of choice for the treatment of disproportion in a first labour, but in particular cases in which the first labour ended with a difficult forceps delivery on account of a moderate degree of disproportion, induction of labour at the 38th week can be considered in subsequent pregnancies.

Antepartum hæmorrhage. Induction of labour by rupture of the membranes is a method of treating accidental hæmorrhage and lateral placenta prævia.

Hydramnios. Induction of labour by rupture of the membranes may be indicated in this condition, particularly when it is associated with an unstable presentation in the case of a multigravida, or with gross fœtal abnormality such as anencephaly.

Anticipated death of the fœtus. Intra-uterine death of the fœtus may be associated with essential hypertension, diabetes and rhesus incompatibility, but in many cases no cause can be found. When there is a history of fœtal death in a previous pregnancy it is reasonable to consider the induction of labour soon after the 36th week in order to obtain a live child.

If intra-uterine death has occurred labour will eventually begin. However, the knowledge that the baby is dead is most distressing to the mother and, since the presence of a dead fœtus *in utero* for long period of time may very occasionally give rise to afibrinogenæmia, it is justifiable to induce labour at the end of a week from the time of the intra-uterine death. Medical induction with a pitocin drip is almost always successful in causing the onset of labour; rupture of the membranes is to be avoided owing to the risk that the macerated fœtus may become infected.

Breech presentation. When attempts at external cephalic version have failed, induction of labour is sometimes advocated about the 38th week to obtain an easier delivery of the after-coming head. This form of treatment should be considered in a primigravida with an average but not capacious pelvis, or when the baby seems to be above average size, and in multiparæ whose babies have been getting progressively larger with each pregnancy. In such cases rupture of the hind waters is the method of choice as it excludes the risk of prolapse of the cord and some of the liquor is retained.

Methods

The methods of induction of labour are divided into two types, (*a*) medical when drugs are used to stimulate uterine contractions, and (*b*) surgical when physical stimulation is applied direct to the cervix and lower uterine segment by rupturing the membranes. It is most important that induction of labour should be carried out only for those cases in which it is considered that the delivery is a matter of urgency, either for the mother or the child. In no circumstances should it be undertaken for the convenience of the patient or her medical attendant. Once induction is instigated it must be carried to its logical conclusion, and should both medical and surgical induction fail it will be necessary to proceed to Cæsarean section.

Medical induction of labour

Medical induction of labour may be tried in any of the conditions for which surgical induction is indicated provided that the indications are not urgent and the patient is near term. It often fails, and is therefore contra-indicated in urgent cases in which a speedy onset of labour is essential. Its great advantage is that it does not carry any risks of infection to either the mother or child. The simplest method is a hot bath followed by an enema, but this will only succeed if labour is about to begin. The giving of castor oil has now been discontinued.

The drug most commonly used for the medical induction of labour is oxytocin. This was formerly given by intramuscular injection of repeated doses of 2 units, but this method of administration can be dangerous because it may produce violent uterine contractions of long duration which may cause intra-uterine death of the fœtus from asphyxia or even rupture of the uterus.

Oxytocin used for induction of labour should be given by the intravenous drip method. This has the advantage that the drug acts continuously and the dose can be accurately regulated to the requirements of the patient.

Oxytocin Drip. A dilute solution of oxytocin or synthetic oxytocin (syntocinon) is given by slow intravenous infusion. The drip contains 0·5 units of natural or synthetic oxytocin in 500 ml. of 5 per cent dextrose solution and it is run at 75 to 30 drops per minute. It should only be done in hospital as it is essential that the patient should be under constant observation during the administration of the drip and that a chart be kept of the strength and time intervals of the uterine contractions; the fœtal heart should be auscultated at 15-minute intervals. If the contractions are weak and irregular the rate of the drip is increased until satisfactory contractions occur and the concentration may be increased if necessary to 2 units in 500 ml. When the contractions are regular the pitocin solution can be turned off and the drip continued with the plain glucose solution; but it is usually advisable to continue the drip slowly until the end of the third stage of labour.

Buccal oxytocin induction. Recently linguettes of 100 units of oxytocin (Pitocin) have been introduced. One or more linguettes are placed in the buccal pouch on the outer side of the gum at hourly intervals and left to dissolve. The disadvantage of the method is that absorption is very irregular, and there have been cases in which unduly violent uterine action has occurred. Intravenous administration is better.

Surgical induction of labour

Artificial rupture of the membranes. Surgical induction is the most certain method of inducing labour, and complications and failures will be few if the pregnancy is near or past term, if the head is engaged in the pelvis, and the cervix is soft and loose. Either the forewaters, hindwaters, or both may be ruptured.

Technique

Whichever method is employed the preliminary steps are the same. The operation should only be performed in the operating theatre or the labour ward. An anæsthetic may be required for a primigravida but it is often

sufficient and preferable to give pethidine 100 mg. and chlorpromazine 25 mg. by intramuscular injection an hour beforehand, or by intravenous injection just before the operation. After emptying her bladder the patient is placed in the lithotomy position and draped with sterile towels, after swabbing the vulva with antiseptic solution. The operator, wearing sterile gloves, gown and mask, now makes a vaginal examination to confirm the presentation of the fœtus. A finger is passed through the cervical canal, and is then swept round inside the uterus to separate the membranes from the lower uterine segment over as wide an area as can be reached. This separation of the membranes off the lower segment is as important a factor in inducing labour as the actual rupture of the membranes; generally it is followed by a little bleeding.

In parous patients and in primigravidæ at or after term the cervix is soft and a finger can easily be passed through the cervical canal, but in a primigravida before term the cervix is relatively hard and may occasionally require dilatation before a finger can be passed into the uterus.

Low rupture of the membranes. This is the method of choice. It is easier, safer and more certain to start labour than high rupture of the membranes. The loss of the bag of forewaters is not now considered to have any adverse effect on the dilatation of the cervix. There is a small risk of prolapse of the umbilical cord if the presenting part is not engaged in the pelvis.

Low rupture of the membranes is done by passing the blades of a pair of Kocher's artery forceps along the fingers up through the cervical canal, seizing the bag of waters with the tips of the forceps and tearing it. If the head is not deeply engaged in the pelvis an assistant should push the head in from above as it not only facilitates rupture of the membranes by making the bag of forewaters tense, but also diminishes the risk of prolapse of the cord. Once the membranes have been ruptured it is essential to let out as much liquor as possible, and if the head is well down in the pelvis it may be necessary to push it up a little to allow some of the hindwaters to escape.

High rupture of the membranes. This method was introduced with the object of keeping the bag of forewaters intact, but is seldom used now as it always carries the risk of damaging the placenta.

A Drew-Smythe catheter is introduced through the cervix, passed round the head outside the membranes, and the hindwaters are tapped by means of a stilette within the catheter.

After rupture of the membranes labour usually begins within 24 hours; the early onset of contractions depends more on the parity of the patient and the maturity of the pregnancy than on the amount of liquor removed. If the contractions do not commence within 24 hours an oxytocin drip should be given to supplement the surgical induction and this is almost always successful. In the cases in which labour has not commenced within

72 hours of the surgical induction followed by an oxytocin drip, the question of Cæsarean section must be considered in the interests of both mother and child.
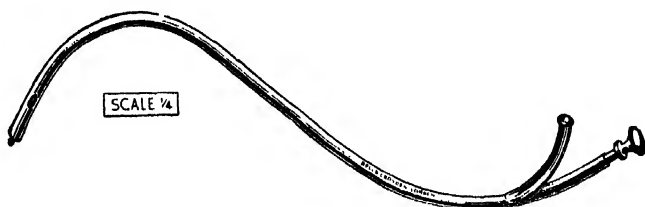
FIG. 221. The Drew-Smythe catheter.

[*John Bell & Croydon*

Prognosis. So far as the mother is concerned, any manipulation, such as those described, is associated with a potential risk of infection. The longer the interval between the rupture of the membranes and delivery the greater the risk. The child also runs a risk of intra-uterine infection, particularly of the lungs, and may die either *in utero* or in the neonatal period from pneumonia. For this reason penicillin 500,000 units is given by intra-muscular injection twice daily if labour does not start within 24 hours. The other risk to the child is that of prematurity, and is therefore great if the induction has to be performed before the 36th week, i.e. in certain cases of toxæmia and rhesus incompatibility.

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PUERPERAL PYREXIA

BY statutory definition the term puerperal pyrexia denotes a rise of temperature to or above 100·4°F (38°C) from any cause within 14 days of labour or miscarriage. It therefore includes all cases of puerperal sepsis. It is the duty of the practitioner to notify all such cases to the local medical officer of health.

The causes of puerperal pyrexia are:
1. Genital tract infection or puerperal sepsis.
2. Urinary infection.
3. Breast infection.
4. Thrombo-phlebitis.
5. Respiratory tract infection.
6. Other causes of pyrexia.

With the decreased incidence of genital tract infections, urinary infections are now the commonest cause of puerperal pyrexia. Recent investigations into the causes of puerperal pyrexia have shown that in rather more then 15 per cent of the cases no cause could be found for the rise in temperature on either clinical or bacteriological examination. In these cases the temperature returns to normal without any treatment, the rest of the puerperium being uncomplicated.

1. Genital tract infection (puerperal fever or puerperal sepsis)

Known as 'childbed fever' this was the scourge of the first obstetric hospitals where the mortality from it was so great that any patient was fortunate who survived her stay in hospital. It was not realized until the middle of the nineteenth century that the cause of epidemic puerperal infection was lack of cleanliness on the part of the attendants who carried the infection from one patient to another. At this time Semmelweiss in Vienna observed that puerperal fever was more common among patients delivered by medical students who had attended postmortem examinations than among cases delivered by the midwives. He believed that the fever was due to products of decomposition and showed that washing the hands in chlorinated lime water reduced the incidence of infection. It is tragic that his contemporaries did not accept his work.

When Pasteur proved that surgical infection was due to micro-organisms antiseptics (and later asepsis) were introduced into obstetric practice and quickly diminished the risks of genital tract infection, but it still remained the most important cause of maternal mortality.

In 1935–36 the sulphonamide group of drugs was discovered and produced dramatic results in the treatment of the most lethal type of infection due to the hæmolytic streptococcus. Penicillin and the other antibiotic drugs have still further reduced the dangers of infection, the great majority of the cases occurring today being of the mild localized type. Puerperal sepsis, once the most important cause of maternal mortality, now accounts for only 4 per cent of all deaths.

Although the incidence and severity of genital tract infection has fallen so dramatically in recent years there is danger in complacency. New strains of organisms resistant to the commonly used drugs appear from time to time and cause outbreaks of serious infection. It is only by strict attention to asepsis and the maintenance of a high standard of obstetric practice that they can be controlled.

Ætiology. When the placenta separates from the uterine wall, a raw area is left which may be regarded as an extensive but superficial wound. Lower down the birth-canal other wounds may be left as a result of delivery; thus the cervix is occasionally torn, the fourchette is commonly torn in first confinements, and sometimes the perineum also. These wounds, the result of labour, may become infected like wounds anywhere else, and the symptoms and physical signs resulting therefrom constitute the disease which was known in the past as childbed or puerperal fever, but is nowadays termed puerperal sepsis.

Any pathogenic organism, if implanted in a wound may grow and multiply, and the wounds left by labour are no exception to this rule.

In practice it is found that in genital tract infection only a few organisms are at all commonly found, namely:

> Anærobic streptococcus
> *Staphylococcus aureus*
> *Streptococcus fæcalis*
> Hæmolytic streptococcus (group A)
> Coliform organisms
> *Clostridium welchii*

Hæmolytic streptococci and staphylococci tend to produce the most serious infections, and *Escherichia coli* the mildest.

Anærobic streptococcus. This is the most frequent cause of infection which is generally localized and of the mild type.

Staphylococcus aureus is often found in vaginal swabs taken from mild cases with a mixed infection, but it is probable that in this type of case the organism is a saprophyte and not the cause of the infection. However, the staphylococcus must be regarded as potentially lethal because it has produced a number of strains resistant to the antibiotics and these are today the cause of a number of fatal cases of infection, particularly after abortion.

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Streptococcus fæcalis gives rise to a mild type of infection.

Hæmolytic streptococci are divided into several grousp (Lancefield classification) but in practice it is only Group A which is responsible for serious infections. Fortunately it is still sensitive to penicillin and the sulphonamides and is no longer the serious problem that it was in the past. Occasionally mild infections occur with Group B organisms.

Coliform organisms are an infrequent cause of infection, which is generally localized to lacerations of the vagina and perineum.

Clostridium welchii, although sometimes found in vaginal swabs, is a rare cause of infection. Considerable tissue damage or a retained dead and macerated fœtus are generally associated with infection by this organism. Jaundice due to hæmolysis may be present, and hæmoglobinuria may occur. Such infections may be fatal within a few days.

Though septic infection of any of the wounds left by labour will produce symptoms, infection of the placental site, as might be expected, produces the most severe illness.

Puerperal sepsis has been shown to be more common after interference in labour by manipulation or instrumental delivery, particularly if there is soft tissue injury of the birth canal. It is well known that trauma partially devitalizes the tissues and lessens their resistance, thus making easier invasion by organisms. The source from which the organisms are derived may be either endogenous or exogenous.

Endogenous infection. Infection caused by organisms already in the patient's body prior to the onset of labour.

Genital tract. Experimental work has shown that small particles, when placed in the upper part of the vagina, find their way up into the uterus within a few hours. It is therefore certain that organisms, whether already present in the genital tract, or implanted there from an outside source, could make their way upwards when the uterus is in free continuity with the vagina. Group A hæmolytic streptococcal infection is almost always exogenous in origin.

On the other hand, infection with the anærobic streptococcus is almost certainly endogenous. It has been shown that this organism is present in the vagina of 30 to 40 per cent of women during the last months of pregnancy, and that it is uncommon elsewhere in the body. Infection with coliform organisms, *streptococcus fæcalis* or *clostridium welchii* is also usually endogenous. Infection is particularly liable to follow manual removal of the placenta or other intra-uterine manipulations.

Intestinal tract. The fæces very rarely harbour the group A hæmolytic streptococcus; they may do so if the patient has had a recent attack of acute tonsillitis, but they cannot be considered a common cause of severe or widespread infection.

Blood stream. Infection may very rarely be carried to the genital tract by the blood-stream from septic foci, such as whitlows.

Exogenous infection. Infection caused by organisms introduced from some outside source. That this is the most important cause of infection was proved without doubt in epidemics of puerperal sepsis due to the hæmolytic streptococcus which, in the past, were common in lying-in hospitals and still occasionally occur. The infection is carried from one patient to another by the hands or breath of the practitioner or nurse, and by dressings and instruments.

The throat and nasal swabs from normal individuals show that 5 per cent carry hæmolytic streptococci and over 50 per cent carry staphylococci. The infection is usually conveyed by the spray of saliva, either during talking, coughing or sneezing, by which instruments, dressings, the attendants hands or the patient's vulva may be contaminated.

The infecting organisms may also come from a septic focus on the skin of the contact. The dust in wards where patients with infections have been nursed is known to harbour the organisms for long periods of time and may thus be a cause of airborne infection.

With the virtual elimination of the hæmolytic streptococcus as the cause of serious infection owing to a probable diminution in its virulence, combined with its sensitivity to penicillin and the sulphonamides, the main danger now is from the staphylococcus owing to the increasing incidence of resistant strains.

With the introduction of the antibiotics it was anticipated that serious infection would become a thing of the past. It would only be necessary to administer an antibiotic to cure every type of infection; unfortunately this has not proved to be true owing to the ability of organisms to produce strains resistant to the antibiotics.

It has been established beyond doubt that the widespread use of antibiotics leads to the emergence of resistant strains. Laboratory tests show that organisms originally sensitive have now become resistant. An antibiotic kills bacteria by interfering with their metabolism, thus stopping a specific process.

Resistant strains of bacteria arise spontaneously by mutation. Resistance depends on the acquisition by the bacteria of an alternate chemical process by which its metabolism may be maintained or by the production of an enzyme to destroy the antibiotic, for example, penicillinase produced by naturally resistant staphylococci.

As already stated a very high proportion of normal healthy persons are nasal carriers of staphylococci so that a considerable number of strains are present amongst the medical and nursing staff and patients in any hospital. Before the widespread use of penicillin only a very small proportion of

these strains was naturally penicillin-resistant, so that the great majority of infections were caused by sensitive strains. The introduction of penicillin treatment resulted in the sensitive strains being practically eliminated whilst the resistant strains were encouraged to flourish. The result is that the incidence of carriers of resistant strains of staphylococci among hospital nursing staffs has now risen to between 70 to 80 per cent, these resistant strains are also harboured in dust and bedding. Staphylococci may colonize the umbilical stump of the newborn child, and organisms from this site may spread to other infants in the nursery.

Infection with penicillin-resistant strains of staphylococci in hospital practice is not only of importance in puerperal sepsis, but also in breast infections, and this organism is also a source of danger to the newborn baby.

Pathology. The organisms, having gained a footing in the wound or wounds, set up a suppurative or necrotic inflammation. The subsequent course of events will depend on these factors:

    1. The virulence and powers of invasion of the organisms.

    2. The resistance of the patient.

    3. The amount of tissue trauma.

If the infection remains localized, the woman suffers from a mild or moderate toxæmia as the result of absorption from the infected area, but the outlook is good compared with that which obtains when it spreads beyond the original focus. Extension of the infection may be by direct spread through the tissues; direct spread up the birth-canal, or spread *via* the blood-vessels. Such spread may be local or general.

Local spread extends from the site of infection by direct spread and along the lymphatics and veins to neighbouring tissues, for example to the uterine muscle and Fallopian tubes and thence to the peritoneum, giving rise to peritonitis, or to the pelvic cellular tissue with resultant pelvic cellulitis.

Generalized spread implies the entrance of the organisms into the blood-stream, producing septicæmia. It is most serious, for parts of the body remote from the original focus, such as the lungs, pleuræ and pericardium, may be infected. Occasionally, abscess formation occurs in such places remote from the original focus, and to this clinical condition the name pyæmia is applied. When the infection remains localized in the wounds or spreads locally in the pelvis, the symptoms produced are in the main due to toxic absorption from the area of infection. When the infection becomes generalized by the blood-stream, with or without distant abscess formation, the symptoms may be produced from any infected organ however distant it may be. The degree of toxæmia will be least when the infection is limited to the wounds, more when it has spread to neighbouring

structures, and most severe in septicæmia. It is important to remember that in the most severe cases at first the patient often looks and feels well.

Signs and symptoms. The cardinal and earliest symptom of puerperal sepsis is fever. Labour does not, as a rule, produce any rise in a woman's
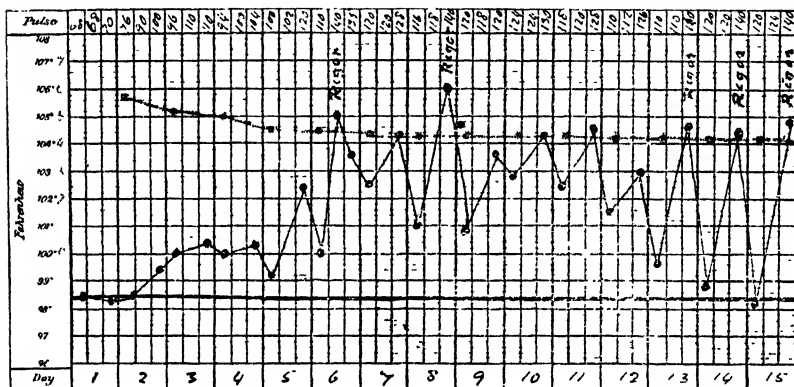
FIG. 222.   A case of puerperal sepsis of the septicæmic type, but in which the pyræxia on the third, fourth, and fifth days suggested a simple toxæmia (sapræmia).
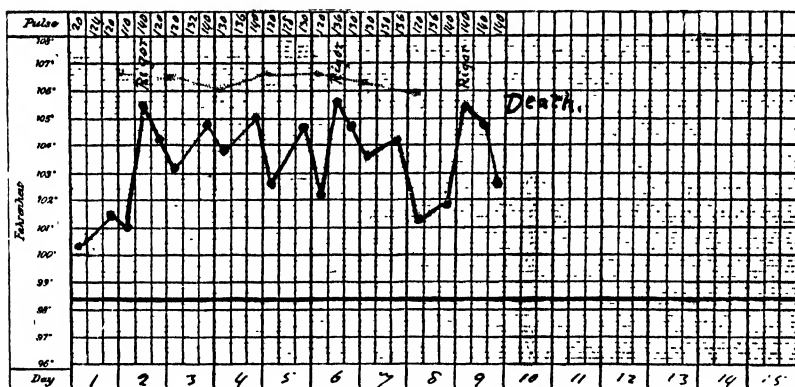
FIG. 223.   A case of fulminating puerperal infection fatal on the ninth day.
Note the high level of the pyrexia and that fever was already present at the termination of labour.

temperature, and the puerperium should be apyrexial. The fever of puerperal sepsis may appear within 12 hours of delivery, or be delayed to the 2nd week of the puerperium, but it most commonly appears between the 3rd and 7th days.

The rise may be abruptly high, in which event it is often accompanied by a rigor, or it may be step-like and spread over several days before a maximum is reached. Coincident with the fever, the pulse-rate is quickened, and the woman may feel ill, although even in a grave case she may often say how well she is. There is no pain at first, and often none at any time, yet tenderness over the lower abdomen is common. If, as occasionally happens, peritonitis or pelvic cellulitis develops, pain is usually localized to the pelvis or lower abdomen. The mental condition is usually extremely clear and alert, even up to a few hours before death. The rigor which ushered in the fever may not be repeated, or may recur again and again, usually in the evening coincidentally with a rapid rise in the temperature. Some patients never have a rigor, and in others rigors appear only after the fever has lasted some days. The character of the pyrexia varies. It may maintain a constant high level, or it may be irregular.

In rare cases, especially when associated with terminal general peritonitis, fever may be absent throughout. The pulse-rate as a rule varies with the height of the temperature, but in the worst cases a high rate is maintained whether the temperature is high or low.

Pelvic cellulitis and salpingitis are both late stages of genital tract infection, and do not usually appear until the 2nd week of the puerperium. Pelvic cellulitis is due to spread of infection along the lymphatics to the pelvic cellular tissue in the broad ligament and lateral pelvic walls, and usually follows a deep cervical tear. It is associated with pain low down in the abdomen and in the inguinal regions. Diarrhœa and dysuria may occur.

Salpingitis, from spread of infection into the Fallopian tubes, gives rise to very similar symptoms. The pain is generally more severe than that associated with pelvic cellulitis, and there is a greater frequency of lower abdominal rigidity and distension. Both conditions may be associated with localized peritonitis.

The diagnosis of general peritonitis may be very difficult, especially as the characteristic signs of this infection may not be present. On the other hand, its presence should be strongly suspected if abdominal distension, generalized tenderness, and diarrhœa are associated with fever in the puerperium.

Diagnosis. Pyrexia following labour and persisting for more than 24 hours must always be assumed to be due to infection of the genital tract, until such an infection has been excluded by bacteriological examination of the lochia. The routine examination consists of a careful clinical examination including throat, chest, breasts, and abdomen, followed by taking a vaginal swab and a mid-stream specimen of urine for examination and culture. In taking a vaginal swab it is only necessary, after preliminary swabbing of the vulva, to separate the labia and pass the swab up into the

vagina; there is no need to pass a speculum or visualize the cervix. The pathologist should be asked not only to report on the organisms cultured, but also to do sensitivity tests against the sulphonamides and antibiotics for any pathogenic organisms cultured; if this is done as a routine, much valuable time will often be saved in beginning the most effective form of therapy. There is no indication for a routine vaginal examination, unless pelvic cellulitis or salpingitis is suspected. In most cases of pelvic cellulitis a vaginal examination will show induration of the parametrium spreading

FIG. 224.   The uterus and appendages looked at from behind.

A pyosalpinx on the right side and an ovarian abscess on the left side due to puerperal infection. The manner in which the swelling on the left side has burrowed under the left broad ligament should be noted. This is very characteristic of an ovarian abscess and causes it to simulate pelvic cellulitis.

out to the lateral pelvic wall; it is usually unilateral and pushes the uterus to the other side of the pelvis. With extensive cellulitis the whole pelvis feels solid, and the area of induration may be palpable in the lower abdomen. In salpingitis a tumour, composed of the enlarged tube and ovary, with adherent omentum and bowel, can be felt behind and lateral to the uterus, on both sides.

Clinically, infections of the genital tract may be divided into two types:

(1) When there is obvious evidence of infection as shown by a bulky tender uterus which is not involuting normally, and a purulent offensive vaginal discharge or excess of lochia. There may also be obvious signs of infection in vaginal or perineal lacerations. This type of infection is often associated with retention of a portion of the placenta or membranes. The rise in temperature occurs about the 3rd to the 5th day, and the organisms

most commonly responsible for this localized type of infection are the anærobic streptococcus, staphlococcus and *Escherichia coli*.

(2) There may be no abnormal physical signs at all. Some of the worst cases associated with septicæmia are of this type, and show how essential it is to have a vaginal swab examined in every case. The rise in temperature generally occurs between the 1st and 3rd days. The finding of streptococci, although not positive proof that the symptoms are due to sepsis, is extremely suggestive of it. The presence of staphylococci, coliform and diptheroid organisms is less positive, since these organisms are more commonly found in the vagina. In all severe cases a blood-culture should be done at the height of the rigor; the finding of organisms proves septicæmia, but their absence on one examination does not exclude it.

Prognosis

Acute anærobic streptococcal endometritis may occur in patients whose tissues have suffered undue trauma during delivery, because damaged tissue and blood-clot form a good culture medium for such organisms. The resulting illness is often prolonged, although the temperature and pulse-rate may never reach a great height.

In patients severely ill who have few or no physical signs, the prognosis is serious, and even more serious in those from whose blood the hæmolytic streptococcus is isolated. A negative finding on blood examination is hopeful and so, on the whole, is the finding of some definite gross lesion, for instance, cellulitis, capable of causing the symptoms exhibited.

If the blood-culture is positive, the number of streptococci per cubic centimetre of blood will form a guide in making a prognosis.

Generalized peritonitis is always serious, and if septicæmia is also present the mortality is even higher. The use of sulphonamides and the antibiotics has undoubtedly lowered the frequency with which general peritonitis occurs.

The height of the temperature is of less importance than the rapidity of the pulse-rate. When the latter remains at 120, or over, the case is a grave one. Rigors indicate the launching into the circulation of potent doses of toxin, and are, therefore, of grave import, especially if frequently repeated. A high leucocyte count suggests some local suppuration and, in so far as it points to a local lesion and a healthy reaction to it, is favourable. In the worst cases, diarrhœa and incontinence of urine may be present, and when associated with extreme mental alertness the prognosis is very poor.

Preventive treatment. If labour is regarded in the light of a surgical operation, a death-rate from sepsis of about 0·1 per thousand is low. If we regard it as a natural process, it is high. Whether high or low, before the introduction of penicillin and the sulphonamides the death-rate from

puerperal sepsis had remained practically constant for many years, notwithstanding an immense amount of effort, whilst the death-rate from sepsis following surgical operations had steadily diminished.

The origin of the infecting organisms and the agency by which they are transported to the uterus in any individual case are now fairly well understood and, therefore, it is the duty of the medical attendant to take every possible precaution to prevent infection from an outside source, during both pregnancy and labour. During pregnancy foci of infection should be looked for, and if found, treated; abstention from coitus during the last two months is advisable. Vaginal examinations are necessary at some time during pregnancy, but they should be kept down to the minimum. In addition, the same strict antiseptic technique should be carried out in making a vaginal examination in pregnancy as in labour. During labour vaginal examinations should be reduced to a minimum. Further, since it is known that sepsis much more commonly follows instrumental and assisted delivery than natural labour, interference should be restricted to those cases in which it is really necessary.

The risks of exogenous infection can be diminished by adequate sterilization of all instruments, appliances and dressings to be used, and thereafter by seeing that they are not infected by contact or spray.

The risks of exogenous infection can be diminished in the following ways. By adequate sterilization of all instruments, appliances and dressings to be used, and thereafter seeing that they are not infected by contact or spray.

The obstetrician should work in sterile gloves and gown, all in attendance throughout labour and delivery must wear a mask which covers both nose and mouth. Masks are best made of two layers of cotton with a layer of paper intervening.

Septic patients must be isolated, ideally in a different building so that there is no mixing of the nursing staff between the clean and septic wards. If the patient has been delivered at home she should be removed to a special isolation hospital where there are adequate facilities for investigation and treatment.

A constant watch must be kept on the medical and nursing staff to exclude from the department any obvious sources of infection such as sore throat, paronychia, boils and whitlows. In the event of the occurrence of more than a sporadic case of infection it is essential that swabs be taken from all those working in the department so that the source of the infection can be traced and removed.

Dust is an important source of cross infection. It can be kept down to a minimum by using vacuum cleaners instead of brushes, oiling floors and frequent washing down of walls. Blankets collect dust and the woollen variety are difficult to sterilize, they should be replaced by the terylene type.

Bed-pans must be sterilized after use and soiled vulval pads should not be allowed to collect but should be burned in an incinerator with the minimum of delay.'

The prevention of endogenous infection is a far more difficult problem. It is impossible completely to sterilize either the vagina or vulva. In normal circumstances, the vagina does not contain organisms of high virulence, but the vulva and the peri-anal region are heavily infected with intestinal organisms such as *Escherichia coli* and *Streptococcus fæcalis*. These organisms are all potentially pathogenic. It is impossible to pass anything, whether sterilized or not, into the vagina, without conveying into it organisms from the introitus. In order to minimize this risk the vulva and peri-anal region must be swabbed with an efficient antiseptic, such as chlorhexidine, prior to making a vaginal examination. When manipulation or instrumental interference during labour is called for, the patient should be placed in the lithotomy position as in an operating theatre, the vulva, and especially the region round the anus, covered with antiseptic sheeting, and the vaginal orifice and such part of its approaches as remain uncovered swabbed with the antiseptic.

The most dangerous of all procedures is to introduce anything into the uterus after the child is delivered. Manual removal of the placenta should, therefore, be avoided unless there is an absolute indication.

The general use of antibiotics and chemotherapy for prophylaxis cannot be too strongly condemned. It is not only ineffective, but positively dangerous, as it encourages the production of resistant strains of organisms.

General treatment. The patient must be nursed in isolation. If the pyrexia occurs in domiciliary practice the patient should be transferred to an institution where all facilities for diagnosis, nursing and treatment are available.

The fluid intake must be adequate and the patient made comfortable by good nursing, analgesics to relieve pain, and sedatives to ensure rest. Hæmoglobin estimations should be done every 2 or 3 days since anæmia is commonly associated with severe sepsis and one or two transfusions of fresh blood may be required.

Local treatment. If an infected perineal wound is present, the stitches should be removed and the laceration irrigated with an antiseptic.

In cases of pelvic cellulitis or salpingitis heat may be applied to the lower abdomen by kaolin poultices, or a radiant heat pad. Hot vaginal douches or pelvic diathermy may be used in cases of chronic cellulitis, because the local application of heat may assist resolution or result in an abscess pointing externally, when it can be incised and drained.

Antibiotics. The importance of sensitivity tests done as a routine on the organisms cultured from the first vaginal swab has already been mentioned, since these tests will enable the correct antibiotic to be selected with certainty, but at least 48 hours and probably longer must elapse before this result can be obtained.

In view of the decreased incidence and severity of genital tract infection there is no urgency in starting antibiotic therapy. It is, therefore, generally wise to wait until the infecting organism has been identified by bacteriological findings. Treatment can then be started with the correct antibiotic.

Operative. Operative treatment has little place in puerperal sepsis, and is generally confined to exploration of the uterine cavity for the removal of retained pieces of placenta. It is sometimes necessary to drain a pelvic abscess by an incision either in the posterior vaginal fornix or rectum. Pelvic cellulitis may sometimes result in an abscess pointing under the skin of the abdominal wall, generally just above the outer end of the inguinal ligament, or below the kidney in Petit's triangle. Treatment is by incision and drainage.

2. Urinary tract infection

Infection of the urinary tract is the commonest cause of puerperal pyrexia. The infection is almost always introduced by catheterization, which is frequently necessary during labour and sometimes in the puerperium. The infection is generally due to *Escherichia coli.*

During the second stage of labour the patient is often unable to pass urine spontaneously owing to pressure on the urethra by the presenting part, and the stretching of the urethra due to elevation of the bladder. Besides giving rise to considerable discomfort, the distended bladder inhibits the expulsion of the child, and it is therefore necessary to empty the bladder by catheterization. Catheterization is essential before forceps delivery, because a full bladder, predisposing to uterine inertia, will almost certainly result in postpartum hæmorrhage.

After delivery, particularly when there has been a perineal laceration or episiotomy requiring sutures, the painful perineum inhibits the act of micturition, and this leads to retention of urine which will require relief by catheterization on at least one occasion. Apart from catheterization, the bruising and stretching of the tissues during delivery may be sufficient to give rise to a recurrence of a pre-existing chronic and symptomless infection.

Diagnosis. This is made on examination of a mid-stream specimen of urine. Part of the specimen should be sent to the laboratory for examination of the deposit, culture and sensitivity tests, but immediate examination of a

drop under the microscope will often settle the diagnosis; a large number of pus cells in the field makes the diagnosis of a urinary infection certain. The symptoms of such infection, dysuria and frequency, are often equivocal, since they are common after delivery even in the absence of infection.

Treatment. In order to prevent urinary infection, catheterization should be restricted to those cases in which it is indicated, and then performed with strict aseptic technique. When there is a history of a recent urinary infection, a small prophylactic dose of one of the sulphonamides, may be given during labour and continued for the first 3 or 4 days of the puerperium.

In the established case the fluid intake must be at least six pints in the 24 hours. The urine should be made alkaline by giving a mixture of potassium citrate 2 G. (gr. 30) and sodium bicarbonate 2 G. (gr. 30) 4-hourly, or more frequently if necessary, as judged by testing every specimen of urine with litmus paper, and a course of one of the sulphonamide drugs should be given, e.g. 1·0 G. sulphadimidine 4-hourly, up to a total of 25 G.

Occasionally the sensitivity tests may show that the organism is resistant to the sulphonamide group of drugs, and it will then be necessary to use the appropriate antibiotic.

3. Breast conditions

After urinary and genital tract infections, the breasts are the commonest cause of pyrexia in the puerperium. Two conditions arise, engorgement and infection.

Engorged breasts

About the end of the 3rd day the breasts become engorged with blood and begin to secrete milk, and if the baby does not empty them sufficiently, the breasts rapidly become over-distended. They are enlarged and covered with dilated veins; the skin over them may be slightly congested. They are very tender and painful, and when touched are found to be hard and knotty. Nodules of engorged breast tissue may be palpable in the axilla. Such a condition is very painful to the patient and may prevent her sleeping.

Treatment. Prophylactic treatment of the breasts during pregnancy will help to promote successful breast feeding by preventing engorged breasts with the risk of subsequent infection.

The nipple should be protractile, that is to say it should stand out well when grasped between the finger and thumb, so that when the baby sucks he can get the whole nipple into his mouth with his jaws around the areola. If the nipple is retractile the baby will be unable to get it properly into his

mouth and tends to bite it causing abrasions which will be a cause of pain to the mother and may lead to infection.

A retractile nipple can frequently be converted into the normal protractile type if suitable nipple shells are worn under a well fitting brassiere during the last three months of the pregnancy.

In order to prepare for lactation and ensure an easy flow of milk along the ducts of the breast and from the nipple expression of colostrum from the breasts is practised for 10 minutes a day for the last 2 months of the pregnancy. There is no doubt that this practice greatly diminishes severe breast engorgement during the puerperium.

In the early stages of engorgement the child may be able to take enough milk to relieve the congestion but once the condition is fully established, there is sufficient congestion and pressure on the ducts to prevent the flow of milk and the child from emptying the breasts so that they become extremely painful and tender. This engorgement can be relieved by giving œstrogens, e.g. ethinyl œstradiol 0·2 mg. if necessary repeating the dose in 6 hours. A little milk should be manually expressed before putting the baby to the breast as this will help to promote an easy flow of milk. Hot fomentations are also helpful in relieving the pain and congestion of the acute stage and a sedative should be given at night. Adequate support of the breast is essential.

Acute puerperal mastitis

Infective mastitis has now almost completely replaced genital tract infection as the cause of prolonged morbidity in the puerperium.

The infecting organism is almost always the *staphylococcus aureus*, frequently of the resistant phage type 80. All that has been said regarding the prevalence and problems of infection with this organism in relation to puerperal sepsis applies equally to breast infections. In addition the baby is a frequent source of infection to its mother's breasts. It has long been known that breast infections were liable to occur in association with skin infections of the baby and that such infections spread rapidly in a nursery unless isolation and the most careful aseptic techniques are practised.

Bacteriological investigations carried out in recent epidemics of breast infections with the *staphylococcus aureus*, phage type 80, have shown that if one baby in the nursery has the organism in its nose or mouth, almost all the other babies will be similarly affected within 2 or 3 days. These affected babies, seldom ill and generally thriving, are a dangerous source of infection to their mothers.

There are two main types of mastitis depending on the site of infection, cellulitis when the infection enters a crack in the nipple and spreads to involve interlobular connective tissue, and adenitis, when the infection is primary in the lactiferous system, there being no break in the surface

epithelium of the nipple. The second type is seen in epidemics and is confined to hospital practice. The condition may arise at any time in the puerperium. The onset is rapid, the patient complains of pain in the breast and her temperature may rise as high as 105°F within a few hours. In both types the clinical picture is the same, the infection being limited at first to one lobe. A wedge-shaped area of cutaneous hyperæmia seen with its apex at the nipple, and the affected area of the breast is tense and tender. In the early stages generalized aching pain and malaise may mask the local signs. Unless early treatment is successful the condition will progress to a breast abscess.

Treatment. Prophylaxis consists in the most scrupulous attention to asepsis. Any baby or mother with an infection must be removed from the nursery, or ward, and isolated. The umbilical cord is a common site for infection and must be inspected daily. Ideally the mother and baby should be kept together; the mother should, as far as possible, be encouraged to attend to her baby's needs herself, thus reducing its handling by other persons to the minimum.

Routine bacteriological checks should be made in the labour wards, lying-in-wards, and nurseries for the sterility of instruments, dressings and appliances. It is only by constant vigilance that serious epidemics can be prevented.

As soon as mastitis occurs breast feeding should be suspended on the affected side and the breast emptied by gentle expression (or with an electric pump if that is available). The breast should be firmly supported over a large pad of cotton wool. A sample of milk should be taken and sent to the laboratory for culture and sensitivity tests, as it is almost always possible to grow the infecting organism from the milk.

If antibiotic treatment is going to prevent an abscess it must be started immediately. Penicillin 500,000 units by intramuscular injection given twice a day for 48 hours may result in resolution without abscess formation in domiciliary practice when the organism is likely to be sensitive. In hospital the organism will probably be penicillin resistant but the sensitivity of the prevalent strain will often be known and treatment with the appropriate antibiotic should be started. When the report on the culture from the milk is available it will provide an accurate indication as to the choice of antibiotics.

Abscess of the breast

A mammary abscess follows acute mastitis which has failed to resolve. A segment of the breast becomes painful, tender, œdematous and usually reddened. The temperature is raised, the pulse-rate is quickened and the axillary glands become tender and enlarged. The abscess may form near

the surface or in the substance of the breast. The latter is naturally more serious and, if neglected, may burrow deeply in all directions and lead to almost total disorganization of the breast.

Treatment. Breast feeding and proper treatment of the breast abscess are incompatible. The baby must be taken from the breast, alternative feeding arranged and lactation supressed by œstrogen therapy. As soon as an abscess forms it should be drained. To wait for fluctuation is to wait too long, the presence of brawny œdema of the skin makes the diagnosis almost certain. The incision should radiate from the nipple in order to avoid cutting the ducts. Since these abscesses have loculi running in different directions, and not infrequently consist of a superficial and deep portion connected by a narrow track, the incisions should be free and deep and the gloved finger should be inserted into the abscess and all septa and loculi broken down. A drainage tube should be inserted and it is sometimes necessary to make a counter-incision to obtain dependent drainage.

The prevention of lactation. Œstrogens have proved to be the most efficient therapeutic agent for inhibiting the secretion of milk, after lactation had been established.

When the mother is not going to feed her child for any reason the secretion of milk can be prevented by giving ethinyl oestradiol 1 to 1·5 mg. daily, for the first 5 days after delivery. Limitation of the patient's fluid intake may be required, and daily bowel action ensured by giving laxatives if necessary.

When the mother has nursed the child for some months and is going to wean it, similar treatment will be efficient in stopping secretion. The process of weaning, which formerly took two or three weeks, can, so far as the mother's comfort is concerned, be completed in 3 or 4 days.

4. Thrombo-phlebitis

This is a late cause of puerperal pyrexia, as it generally occurs about the 10th day of the puerperium, but may be as early as the first or as late as the 20th day.

Ætiology. Thrombo-phlebitis is frequently associated with anæmia, pelvic infection, and difficult delivery with tissue damage. Varicose veins predispose to superficial thrombo-phlebitis. Many cases arise without any obvious predisposing cause, but it is most probable that they are generally associated with a mild pelvic infection, for on looking back on cases which develop thrombosis, it is common to find that the patient had a low grade pyrexia in the region of 99°F for several days, and a pulse rate higher than would be expected from this temperature,

Deep thrombo-phlebitis

Diagnosis. Pain generally commences in the calf of the leg, also behind the knee and in the ankle, and is accompanied by œdema of the leg and ankle. The thrombosis may spread upwards to involve the superficial or deep veins of the thigh, when the pain and swelling will extend up to this region also. If the main lymphatics of the limb are also involved in a deep cellulitis, the whole limb may become solid with œdema; the skin is white and shiny, and the limb is very much enlarged giving rise to great discomfort. This is the condition known as white leg or phlegmasia alba dolens, now fortunately a rare condition.
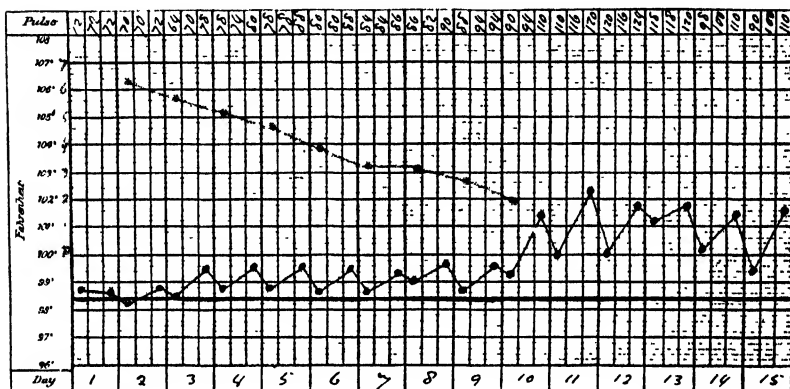
FIG. 225. A case of femoral thrombo-phlebitis.

Note that the pyrexia which began on the 10th day was preceded for several days by slight irregularity of temperature. This is the normal course of events in such cases. The involution curve is practically normal.

It is of the utmost importance that thrombosis should be diagnosed when it is still limited to the deep veins of the calf. The early signs are tenderness on deep palpation in the back of the calf, associated with œdema of the leg. Passive dorsiflexion of the foot while the knee is kept extended gives rise to pain in the calf. If the thrombosis is spreading upwards, involvement of the popliteal vein can be demonstrated by palpating the tender thickened vessel.

Prognosis. This has been completely altered by the introduction of the anticoagulant drugs. Prior to the introduction it was necessary to keep the patient in bed until the temperature and œdema had subsided, a period of 6 to 10 weeks, but the anticoagulants have cut this time down to a few days.

The prognosis is generally excellent, but even with anticoagulants death occasionally occurs from pulmonary embolism or thrombosis of the inferior vena cava.

Treatment. The best way to prevent deep femoral thrombosis is by careful and gentle delivery to avoid tissue damage as far as possible; to treat anæmia by the administration of iron during pregnancy, by blood-transfusion when the patient has had postpartum hæmorrhage; by prevention of puerperal sepsis; and by encouraging early ambulation and advising routine postnatal exercises, beginning on the day after delivery.

Anticoagulants. Heparin was the first anticoagulant to be introduced. Its main disadvantage is that it must be given by intravenous injection but this can be largely overcome by inserting a Gordt needle into a vein, where it can remain for several days, and giving the heparin through this.

Heparin has the advantage that it acts quickly and is also rapidly excreted from the body so that if a hæmorrhage occurs it is generally only necessary to stop administration of the drug. The antidote is protamine sulphate, 1 to 5 ml. of a 1 per cent solution being injected intravenously.

The other anticoagulants in common use are Tromexan and Dindevan. Both have the advantage that they are given orally, but their action is delayed for about 24 hours, and the initial period is generally covered by several doses of heparin. Since their effect is variable the dosage has to be regulated against the patient's prothrombin time so that they can only be used when laboratory facilities are available.

On the first day of treatment 150 mg. of heparin are given intravenously initially and followed by 100 mg. intravenously every 6 hours, the first dose being combined with either Tromexan, 1,200 mg., or Dindevan, 300 mg., given by mouth. On the following days the treatment is continued with Tromexan or Dindevan given in divided doses two or three times a day, the amount being regulated by the prothrombin time which should be kept at two to two and a half times the normal.

It is essential to give an adequate course of anticoagulant therapy extending over at least 10 days; this treatment frequently produces hæmorrhages from the placental site, gums and renal tract. These hæmorrhages are usually slight and of no consequence, but occasionally, particularly early in the puerperium, severe hæmorrhage may occur from the placental site; in this case the anticoagulant must be stopped and the patient given phytomenadione (vitamin K_1) 150 mg. intravenously, and a blood-transfusion.

The pain and pyrexia generally subside quickly on anticoagulant therapy. Leg exercises are encouraged in bed and once the pain has subsided the patient may be up and about with a full-length crêpe bandage or elastic stocking support for the affected leg. There is often some residual œdema of the leg which may persist for some months, or even remain permanently. An elastic stocking, put on in bed before getting up in the morning should be worn for 3 to 6 months.

Superficial thrombo-phlebitis

This occurs with some frequency in the superficial veins of the leg and usually, is not of serious import. The skin over such a thrombosed superficial vein will be red, and the solid clot in the vein can be palpated with ease. Although tender at first, the pain will gradually disappear. Treatment is best carried out by strapping the whole area with Elastoplast, and getting the patient up and walking as soon as possible.

Since recovery is the rule and there is little risk of embolism anticoagulants are not used.

5. Respiratory tract infection

Infections of the respiratory tract may arise at any time, and the puerperium is no exception. When an anæsthetic has been given during labour, post-anæsthetic chest complications, such as basal collapse, and bronchiopneumonia.

6. Other causes of pyrexia

Tonsillitis, influenza, or any of the acute specific fevers, may occur in the puerperium, as well as surgical conditions such as appendicitis.

DISORDERS OF THE BREAST IN THE PUERPERIUM

ACUTE engorgement of the breast and acute mastitis have been discussed in the previous chapter (p. 588). Other disorders which may occur in the puerperium are discussed here.

Cracked nipples. The nipple may become sore and painful from two conditions. One consists of a loss of the epithelium covering a considerable area of the nipple, with the resulting formation of a raw area which is very tender. The other is a small deep fissure situated either at the tip or the base of the nipple. The two conditions frequently exist simultaneously and are referred to as cracked nipples.

The cracks may be caused by lack of care before delivery in not keeping the nipple clean and free from crusts, and also in not treating flatness of the nipple. After delivery a flat nipple, or one that is not kept aseptic and dry, tends to become sore. If there is not sufficient milk in the breast a hungry baby will suck too vigorously and its gums cause abrasions of the epithelium. Another cause is putting the baby to the breast too frequently and leaving it there too long during the first three days after delivery when the supply of milk is not established. The nipples may also become sore if, when the baby is suckled, the mother does not depress the breast away from the baby's nostrils with her fingers, since, if the baby cannot breathe through its nose, it has to drop the nipple repeatedly and then take it up again. Thrush is an occasional cause of soreness of the nipple.

Cracked nipples cause tenderness and pain during suckling. There is also a risk of a mammary abscess forming, as the raw area acts as a means of access for infecting organisms. An important symptom is the vomiting of altered blood by the baby, as it draws maternal blood with the milk into its stomach, and since the blood usually causes vomiting it may give rise to the idea that hæmorrhage is occurring from the wall of the infant's stomach.

Treatment. Cracked nipple should be prevented by the treatment described on p. 163. If the nipples are hard and inclined to crack, lanoline may be applied. During the first 3 days the child should be put to the breast for only a few minutes, and in no circumstances allowed to sleep with the nipple in its mouth. At the end of each feed the nipple must be cleaned and dried as already described. A cracked nipple is a breach in the epithelium which will heal spontaneously if the trauma that produced it ceases. The

first essential of treatment is therefore rest, and the baby must not be put to the breast on that side until the crack has healed. Meantime the breast should be emptied by manual expression or by mechanical breast pump. When breast feeding is recommenced the baby should only be put to the breast for a few minutes at first, otherwise the nipple will crack again. If the lesion is recognized at an early stage it may heal within 48 hours, but once the crack has become extensive or indurated healing will be far more difficult, and in many cases breast feeding is not re-established.

Various local applications have been recommended. Any such application must not stick so that it drags away any newly formed epithelium when it is removed, and it must not be harmful to the baby so that it has to be cleaned off before a feed. Flavine in liquid paraffin is a suitable and harmless antiseptic, which will not adhere.

Galactocele. A galactocele is a retention cyst of one of the larger mammary ducts. Its content is chiefly milk. It is probable that most of these swellings owe their origin to inflammatory changes in the wall of the affected duct, whereby the lumen becomes occluded. As a result the retained milk is usually mixed with pus, and droplets of free fat are often present. A local fluctuating swelling can usually be felt and the skin over it is reddened. The general appearance suggests a large abscess but the pain is much less and there is no constitutional disturbance. A galactocele when small and deeply situated may be mistaken for a carcinoma in the breast. The cyst should be excised.

Galactorrhœa. This is a condition occasionally met with when a continuous flow of pale watery milk occurs from the nipple. The amount lost each day amounts to a considerable quantity. The breast does not in many cases present external signs of great activity, indeed it is often quite flaccid. Sometimes only one breast is affected. The cause is unknown.

The fluid is of little nutritive value. In many cases weaning has already been carried out. If it has not, the child should be withdrawn permanently from both breasts and artificially fed. To stop the secretion of the breasts, the mother should be given an œstrogen such as ethinyl œstradiol 1·0 mg. by mouth daily for 5 days.

Carcinoma of the nursing breast. Carcinoma, when it develops in the nursing breast, grows with great rapidity and is very malignant. The affected breast is larger than the other, the nipple is flattened or retracted and more or less fixed, and the skin over the tumour is in a condition of firm tumidity—the so called pig-skin thickening. It may present a distinct blush or even obvious capillary injection, if the growth is close to the surface.

Immediate recognition is of the utmost importance. The rapidity with which the enlargement makes its appearance and the reddening of the skin over it often suggest mastitis. The fact that the swelling has appeared without pain and is scarcely tender to palpation should at once give a clue to the right diagnosis.

A small deep-seated galactocele may resemble carcinoma, but the cyst may be made to fluctuate and the skin over it is neither adherent nor thickened.

The diagnosis must be confirmed by biopsy and the treatment will then be by irradiation.

BLOOD TRANSFUSION IN OBSTETRICS

ACUTE hæmorrhage of large amount may occur in cases of abortion, central placenta prævia or severe accidental hæmorrhage and in the third stage of labour. If the blood-pressure falls the oxygen supply to the vital centres is endangered and it is of the utmost importance to restore the blood-volume by the urgent transfusion of blood or other fluid into a vein. In 1962 there were 242 maternal deaths in England and Wales, and 43 of these were directly due to hæmorrhage (17·7 per cent). In view of the present availability of blood and plasma substitutes, and because all areas are served by mobile blood-transfusion units ('flying squads'), there can be scarcely any excuse for a maternal death from hæmorrhage in Great Britain. Women who are anæmic are less able to withstand large losses of blood, and blood-transfusion may occasionally be needed to raise the level of hæmoglobin before labour if response to other measures is poor or time is short because term is approaching.

The first successful blood transfusion was carried out on a woman who had had a postpartum hæmorrhage, by Blundell of Guy's Hospital in 1829. However, it was not until Landsteiner in 1900 showed how blood samples could be placed in one of four incompatible groups, the ABO blood groups, that transfusion could be undertaken without great risk of severe, often fatal, reaction. The discovery of the Rh blood group system in 1940 by Landsteiner and Wiener further explained the occasional hæmolytic reaction following transfusion with ABO compatible blood. Since then at least 103 antigens (MN, S and Kell are examples) and their equivalent antibodies have been identified in human blood, but they only cause hæmolytic reactions on very rare occasions and then only in patients who have been immunized by pregnancies or transfusions.

For the blood pressure and the oxygen supply to the vital centres in the brain to be maintained, an adequate volume of blood must be circulating. Whole blood consists of plasma and red cells. For research purposes the volume of circulating plasma can be estimated by measuring the concentration after injection into the blood stream of a dye, such as Evans Blue (T-1824), or radio-active iodine, I^{132}; and the volume of red cells can be estimated by measuring the dilution after injection into the blood stream of a known amount of red cells labelled with radio-active phosphorous P^{32} or chromium Cr^{51}. If the venous hæmatocrit is known, measurement of either the plasma or red cell volume will allow the other volume to be estimated and from these two volumes the total blood volume can be

calculated. More accurate measurements of the total blood volume are obtained if the plasma volume and red cell volume are measured separately. Thus it is found that the average non-pregnant woman weighing 9 stones (57 kg.) has a total blood volume of about 4000 ml. (70 ml. per kg.) with a venous hæmatocrit of 41 per cent. In pregnancy the blood volume increases by about 25 per cent, reaching a maximum between 33 and 38 weeks. This is mainly due to an increase in plasma volume and hence hæmoglobin and hæmatocrit values fall. At the end of pregnancy the total blood volume is about 5000 ml. The pregnant woman at term can tolerate sudden losses of blood up to 1000 ml. without much ·fall in blood pressure, the body adjusting itself temporarily by peripheral vasoconstriction. With greater losses of blood the blood pressure falls and the oxygen supply to the vital centres becomes inadequate. An acute hæmorrhage of 50 per cent of the blood volume, 2500 ml. in the pregnant woman at term, is nearly always fatal if not treated promptly. The rate at which blood is lost is also important; the loss of 1500 ml. in 15 minutes will cause far more disturbance than the same loss over a period of 24 hours. In untreated cases which survive, the blood volume after hæmorrhage is gradually restored over 36 hours due to increase in the plasma volume, and hence the hæmoglobin concentration and hæmatocrit value fall during this time. The rate of restoration of the plasma volume is governed by the rate at which proteins are added to the circulation. The restoration of plasma volume by giving intravenous saline is only of temporary benefit because the saline soon escapes from the vessels into the extra-vascular fluid, but it still may be life-saving.

Although blood is the logical fluid to give to restore blood volume after hæmorrhage, it is a highly complex substance and the greatest care must be taken to ensure complete compatibility before transfusing. Extensive hæmolysis of the transfused cells occurs if they are incompatible and this may lead to further hæmorrhage or even fatal anuria, and if she survives the patient's anæmia remains. There is also the risk of iso-immunization. It is wise to regard the hazards of a blood transfusion as equivalent to those of an anæsthetic. If really indicated no-one would hesitate to embark upon either. On the other hand, neither should be given for trivial reasons.

The indications for blood transfusion are:
1. To restore the circulating blood volume.
2. To restore the oxygen-carrying capacity of the blood.
3. For special indications, such as the replacement of fibrinogen, other plasma proteins or platelets.

Symptoms and signs of acute hæmorrhage in obstetric patients

The sudden loss of blood that occurs in an obstetric patient affords the attendant an opportunity to observe the clinical picture of uncomplicated

acute hæmorrhage that is seldom obscured by other signs or by previous illness of the patient. The effects are similar to those produced by experimental veresection on volunteers, and depend on the amount of blood lost and the rate of bleeding.

The loss of up to 500 ml. of blood usually produces very little effect on the circulation; the blood pressure and pulse rate do not alter as a rule. With losses between 500 ml. and 1000 ml. the effects are not marked unless the patient attempts to sit up. But patients who lose 1000 ml. or more show all the features of wound shock within a few minutes; they are collapsed, restless and pale and the skin is cold and clammy; sometimes they have air-hunger; the pulse is fast and thready and the blood pressure falls. These effects are entirely due to a reduced blood volume, which in turn produces a lowered venous pressure, a low right auricular pressure, and a low cardiac output in spite of the increase in heart rate. A rise in pulse rate and a fall in blood pressure are signs of a reduction in cardiac output. In the supine patient the pulse rate rises before there is a significant alteration in the systolic blood-pressure. An accurate assessment of the blood lost is the most valuable guide as to prognosis and treatment. The fitness of the patient before her hæmorrhage has an important bearing on her ability to withstand severe bleeding. With the same amount of blood lost small, unhealthy, anæmic patients collapse more readily than do large, fit women with previously normal hæmoglobin concentrations. The rate at which the blood is lost is also important, but not nearly so as the amount. Anæsthesia may temporarily postpone the circulatory effects of large blood loss, but unless the blood volume is restored collapse will occur as the anæsthetic wears off.

Indications for transfusion

Following hæmorrhage. The urgency for transfusion depends upon the amount of blood lost and the rate of bleeding; the condition of the patient as a result of hæmorrhage; her state of health before the bleeding; the likelihood of further loss of blood and the possible need for operation and an anæsthetic. Any patient who loses more than 1000 ml. (1·8 pints) of blood rapidly, should be considered as likely to need a transfusion. It is very difficult to estimate the amount of blood loss accurately, and the clinical indication for blood transfusion should also be based on the patient's systolic blood pressure and pulse rate. The time to consider transfusion is before the patient collapses, not after. This is more definitely so if she is known to have been anæmic before the hæmorrhage, if bleeding continues or is likely to recur as in the case of a retained placenta or a placenta prævia, or if an operation, such as manual removal of the placenta or Cæsarean section, is being contemplated.

The risk of hæmorrhage is reduced if the bleeding takes place in hospital where there are facilities for immediate blood replacement. For this reason

it is most important to heed the warning of antepartum losses of placenta prævia and to admit such cases into hospital without precipitating severe bleeding by examining them with a finger through the cervix. If a case of antepartum hæmorrhage is being examined in the operating theatre under an anæsthetic in order to establish the diagnosis, blood should be ready and cross-matched; and it is good practice to have a glucose-saline drip running so that blood can be transfused as soon as it is needed.

In revealed accidental hæmorrhage the loss of blood is sometimes not severe enough to need replacement. But in concealed accidental hæmorrhage the bleeding, both retained in the uterus and passed *per vaginam,* is often heavy and demands transfusion. This is especially so in the unusual complication of this condition in which there is incoagulability of the blood due to afibrinogenæmia. Severe continued postpartum hæmorrhage may occur. For reasons that are not understood, unless the blood transfused is fresh, the fibrinogen replacement is inadequate by transfusion alone and extra fibrinogen must be given.

Sometimes after a traumatic delivery with forceps or following repeated unsuccessful attempts at Credé's expression of the placenta, or in cases of acute inversion or rupture of the uterus, the patient collapses. Such a collapsed condition is often referred to as obstetric shock. Nearly always careful assessment will reveal considerable loss of blood from the uterus or from vaginal or perineal lacerations in these cases, and a large quantity of blood may be retained in traumatized tissues. This explains why they frequently respond quickly to transfusion.

When postpartum hæmorrhage occurs in the patient's home it is most unwise to transfer her to hospital with the placenta undelivered; further severe hæmorrhage may occur while waiting for the ambulance or during the journey to hospital. It is better to bring blood and those expert in giving it to the patient in her own home and to resuscitate her and deal with the obstetric emergency there.

In anæmia of pregnancy. It is impossible to be sure that a patient will not bleed during or after labour and delivery. For this reason it is essential to make sure that pregnant women do not reach term with a hæmoglobin concentration below 11 g./100 ml. (76 per cent Haldane). Almost always a good supply of iron during pregnancy will ensure this. Occasionally the iron is not absorbed or cannot be tolerated and then it has to be given intramuscularly or intravenously. If an iron deficiency anæmia is found late in pregnancy it is possible to give the total dose of iron required in a single infusion, with a very rapid response. Rarely a macrocytic anæmia that fails to respond to iron is diagnosed and folic acid has to be given. On the occasions when an anæmic patient is seen for the first time in pregnancy too late for medical treatment to take effect before labour, a blood transfusion may have to be given. Packed cells may be infused. It is seldom

necessary to give blood in the puerperium to a patient who is anæmic as a result of postpartum hæmorrhage. One bottle of blood will raise the hæmoglobin by only 10 per cent and the response to iron by mouth is usually rapid.

Assessment of the patient after acute hæmorrhage

In deciding whether or not to transfuse a patient, it is important to take into account both the clinical condition and the amount of blood lost. It has been pointed out that a picture of profound collapse can be presented by a patient who has lost only a trivial amount of blood. This is due to a vaso-vagal attack and recovery is spontaneous and rapid if the patient is kept supine. On the other hand a patient who has lost 1000 ml. or even 1500 ml. may appear surprisingly fit and her blood pressure may be nearly normal, but a further relatively small loss may then precipitate severe collapse. The previous blood pressure should also be taken into account, because if there was hypertension before, a normal reading after bleeding may represent a serious fall. An example of this is seen in cases of concealed accidental hæmorrhage in which a serious degree of shock is often accompanied by a normal blood pressure and, for reasons that are not understood, a slow pulse. Although in theory it should be easy to estimate the amount of blood lost, in practice it is often very difficult. The blood is frequently mixed with liquor and is absorbed by bed-clothes, towels, pads, swabs and dressings. Because it is so important in assessing the patient to know accurately the amount of blood lost, every effort should be made to collect and measure the blood as it is shed and, by weighing towels and swabs to estimate the blood absorbed in them. An estimation of the hæmoglobin concentration in the fluid lost will give a rough indication of the dilution with liquor. When this is done carefully it comes as a surprise to the attendants to know how much blood is lost, even in a normal case from episiotomy wounds, vaginal lacerations and the placental site; and then it is easy to understand how frequently the loss in a patient who collapses is grossly under-estimated. If a patient collapses and the amount of blood lost is estimated to be less than 1000 ml. (1·8 pints) it is reasonable in the absence of continued bleeding to wait 10 to 15 minutes with the patient's head lowered provided that the systolic blood-pressure is above 80 mm. Hg in the hope that the blood pressure will rise. When there is any doubt it is better to transfuse, and certainly if the blood pressure remains below 100 mm. Hg. If the loss is more than 1000 ml. and the blood pressure is less than 100 mm. Hg transfusion is indicated; and if the systolic blood pressure is 70 mm. Hg or less and the patient has a rapid thready pulse, pallor, restlessness and vaso-constriction, transfusion should be begun at once in order to save life. In this case a blood substitute such as dextran or gum-saline will be given

while steps are being taken to cross match blood. All patients who lose more than 1500 ml. (2·6 pints) should be transfused even though their general condition and blood-pressure are more or less unaffected. Blood volume estimates using the dye dilution technique, can be made in assessing the need for transfusion, but they take at least 15 to 20 minutes to perform, and in urgent cases it is better to rely on clinical assessment of the patient and estimation of the amount of blood lost.

Technique of blood transfusion

Cross-matching. All pregnant women should have their blood grouped for ABO and Rh early in pregnancy. In extreme emergency it is reasonable to transfuse a patient with blood that is not cross-matched provided it is of the same ABO and Rh groups as the patient's. If the group of the patient is not known the transfused blood will have to be O Rh negative, but because blood of this group is relatively scarce and much in demand it should not be used unnecessarily. In all other cases blood should be most carefully cross-matched before it is transfused. It is nearly always possible to treat even the most severe cases of blood loss with a plasma substitute while compatibility tests are being performed. In an emergency even saline is useful, as it is of prime importance to maintain the blood volume.

Women who have had previous blood transfusions or have delivered babies who might have suffered from hæmolytic disease should be regarded as potentially dangerous recipients of blood transfusion, because they may have in the blood stream circulating antibodies which would react with the appropriate antigen in transfused blood. Extra care should therefore be taken in cross-matching such patients to detect antibodies which, though present in low titre, may yet cause a fatal reaction. A Coombs test is the most sensitive for detection of these antibodies.

For proper cross-matching it is necessary to supply the laboratory with 4 ml. of oxalated blood and some clotted blood in a dry tube. If dextran is being infused, the blood for cross-matching must be taken before any dextran is given, because its presence in the plasma causes rouleaux formation and this interferes with the interpretation of compatibility tests. In urgent cases the tests can be carried out in 30 minutes. First the oxalated blood is used for checking the patient's ABO and Rh groups. Most workers use a tube test; a 2 per cent suspension of red cells in saline is mixed with an equal volume of each test serum in small tubes; the tubes are centrifuged soon after mixing the cells and serum and the sediment is examined under a microscope for agglutination. The same test can be carried out with less accuracy on a slide or tile. Next, the serum in the clotted sample of patient's blood is matched directly against a 2 per cent suspension of donor cells in serum-albumin (equal volumes of AB serum and 20 per cent albumin); the

mixture is placed in a tube and incubated for 15 minutes; the tube is centrifuged slowly and the sediment examined under a microscope for agglutination. For non-urgent cases proper cross-matching takes about two hours. The patient's ABO and Rh groups are checked, using the tube test described above, except that mixtures of red cells and test serum are incubated at room temperature and at 37°C for 20 minutes before the sediment is examined. Then the patient's serum is tested directly for antibodies against a suspension of donor cells in saline and incomplete antibodies are detected by an indirect Coombs test. In this test two drops of a 20 per cent suspension in saline of washed donor cells are mixed with four drops of the patient's serum and incubated for 45 to 60 minutes at 37°C. This allows the donor's red cells to absorb on to their surfaces any globulin incomplete antibodies there might be in the patient's serum. After incubation the red cells are washed three times in saline and two drops of a 20 per cent suspension are mixed on a tile with a drop of antiglobulin serum. If the donor's cells have been sensitized the presence of incomplete antibody will be shown by agglutination, and the time it takes for agglutination to occur will indicate the titre of the antibodies.

Choice of fluid for transfusion

Whole blood. Blood volume can be rapidly restored by giving blood, serum, plasma, albumin or one of several plasma substitutes. Fresh compatible blood is the ideal substance for this purpose. It has the advantage over other fluids that it remains within the blood stream longer and by virtue of the red cells it increases the oxygen-carrying capacity of the blood. About 1 per cent of transfused cells disappear from the circulation daily. In the case of stored blood a percentage of cells equal to the age of the blood in days is hæmolysed soon after transfusion. The drawback to blood is that, owing to human fallibility, its great complexity and the tendency for antibodies to be formed against a few of its many antigens, cases of incompatible transfusion occasionally occur and the result may be lethal. Again, blood is not easily obtainable, the supply of donors being limited, and what stores there are should be kept mainly for cases in whom the transfusion of blood is imperative for the saving of life. For these reasons various substitutes can be used. They should be given in emergency when blood is not available, and in preference to blood unless the loss of blood is so great that the oxygen carrying capacity is seriously reduced.

Plasma. Next to whole blood plasma is the most efficient substance for restoring circulating blood-volume. Unfortunately there is a risk of homologous serum jaundice following the injection of even very small amounts of plasma containing the virus of serum hepatitis. It is believed that about 1 in 200 donors is a carrier of the virus. In the last war, before it was infused, plasma was pooled from the blood of at least 300 donors (large-pool plasma)

and the incidence of hepatitis 3 to 12 weeks after infusion was 10 per cent; when plasma was pooled from not more than 10 donors (small-pool plasma) the incidence of hepatitis was reduced to 1 per cent, and it is even lower if the plasma is stored for 6 months before use. Nevertheless, because some of those cases of hepatitis were so severe as to cause fatal hepatic necrosis, plasma has fallen into disrepute and is seldom used.

Dextran. This substance is a polysaccharide and the molecules are in the form of long chains. Intradex and Dextrovan have molecular weights of 150,000 and 120,000 respectively, and about a third of their volume is removed from the plasma in 24 hours and the rest within a week. Rheomacrodex has a molecular weight of 40,000 and is given as a 10 per cent solution which tends to draw fluid from the tissues. About half of it is excreted in three hours, mostly in the urine. The dextrans have one or two drawbacks. Their presence in the plasma causes rouleaux formation and therefore samples of blood for cross-matching should be withdrawn before any of it is infused. Allergic reactions occur sometimes, although these are rare when dextran is used for therapeutic purposes. More serious is a prolongation of bleeding time as the result of dextran infusion, with a risk of further hæmorrhage due to incoagulability of the blood. An infusion of dextran should be limited to one litre, and as it appears to increase the risk of the defibrination syndrome it should not be used in cases of antepartum hæmorrhage or when there is intrauterine death of the fœtus.

Rate and amount of transfusion

When blood or other substances are being given to restore bloodvolume they should be given as fast as they can be made to run into a vein. If possible, in severe cases 1000 ml. is given in 10 to 20 minutes. There is no need to warm the blood. It is best at room temperature but it can be given straight out of the refrigerator. Unless a heat exchanger is available it takes about 2 hours to warm a bottle of blood, and with heating there is a risk of causing hæmolysis or of decreasing the time of survival of the transfused cells. Unfortunately following hæmorrhage the veins go into spasm as a result of the reactive vaso-constriction and it may be necessary to warm the arm in an attempt to relax the spasm. If the operator has difficulty in inserting a needle into a vein he may have to cut down on to one over the internal malleolus of the ankle, in the forearm or in the antecubital fossa. No advantage has been shown in giving an intra-arterial as as opposed to an intravenous transfusion. The transfusion should be continued until the amount of blood lost has been replaced or until the circulatory failure has been relieved, as shown by a blood-pressure of 100 mm. Hg, a fuller pulse and warm skin and extremities. If citrated blood is used the amount of citrate given must not be counted in estimating the total volume of blood given. In a 540 ml. bottle of citrated blood there is

120 ml. of sodium citrate solution and 420 ml. of blood. Thus a patient who has lost 1600 ml. of blood needs four bottles of citrated blood, not three.

When large amounts of sodium citrate are infused rapidly toxic effects may appear. These are an increase in venous pressure, a fall in arterial pressure, muscle twitching or convulsions, cardiac dysrhythmia and changes in the electrocardiograph. These effects are due to a depression of the ionized calcium in the extra-cellular fluid which causes pulmonary vaso-constriction and loading of the right ventricle, and later has a direct toxic effect on the myocardium. Citrate is normally removed from the circulation by renal excretion and by breakdown in muscles and in the liver. Unless there is liver disease citrate intoxication will not occur unless 1500 ml. of citrated blood are given in 15 minutes, or 5000 ml. in 12 hours. If a high plasma citrate level is suspected 10 ml. of 10 per cent calcium gluconate or 10 per cent calcium chloride should be injected into a vein. This solution must be given extremely slowly, because if it is given too quickly it may cause cardiac arrest, and it must not be put into the transfusion bottle or tubing because of the danger of coagulation.

Care should be taken not to overload the circulation by over-transfusing as pulmonary œdema may supervene. In some obstetric units a rapid estimate of the circulating blood volume is made using the dye solution technique in order to decide on the amount of blood needing to be replaced, but this method takes a certain amount of time with delay in treatment, and is not generally used.

Untoward effects of blood-transfusion

Hæmolytic reactions. Excessive hæmolysis of donor's cells may occur as the result of the transfusion of incompatible blood, of old stored blood or of blood that has been over-heated. The temperature rises during transfusion and there is often a rigor. The patient may complain of pain in the chest and lumbar region, of headache, dyspnœa, cyanosis and of feeling faint. Later urine secretion may be suppressed and jaundice may develop. Hæmoglobin-æmia and hæmoglobinuria are found. Renal failure may be the cause of death after several days. One advantage of rapid compared with slow transfusion is that the reaction produced, if the blood is incompatible, is much more acute and almost invariably leads to the stopping of the transfusion before too much harm has been done. It is a good precaution in all cases of blood transfusion to begin the transfusion rapidly to see if a reaction is produced. A sample of the patient's blood and a few ml. of donor blood should always be kept in a refrigerator for 24 hours after a transfusion for further investigation in case there should be a reaction.

Febrile reactions. These are fairly common and are due to pyrogenic products of bacterial growth in the anticoagulant, in the blood or in the

apparatus. The temperature rises toward the end of the transfusion and usually settles within a few hours.

Allergic reaction. Urticaria, œdema of the face or bronchial spasm may occur, especially in patients who are known to be allergic to pollen, dust, etc. These reactions are seldom severe. They are believed to be due to antigens in the transfused plasma.

Septicæmia. The transfusion of infected blood may lead to a fatal septicæmia. The risk is increased by the use of old stored blood from which samples for cross-matching have been withdrawn, and when the blood has been allowed to remain at room temperature for any length of time. The organisms are usually *pseudomonas* or coliforms. New sterilizing techniques have reduced the risk of blood becoming infected.

Homologous serum jaundice. Although the incidence of hepatitis is much less after the transfusion of whole blood than it is after giving pooled plasma, there is a small risk of the order of 0·5 per cent.

Thrombophlebitis. When an infusion is kept up for many hours thrombophlebitis of the vein that is being used commonly follows. This is more frequent after the use of rubber tubing than of plastic tubing.

Air embolism. This may occur if the level of blood in the bottle falls below the top of the outlet tube, especially if positive pressure is being used because of venous spasm; or if, in the course of changing over bottles of blood, air is permitted to enter that tubing.

Rh sensitization. Even today Rh negative patients are seen who have been transfused with Rh positive blood, often unnecessarily, only to develop antibodies as a result. Since there is a 50 per cent chance of sensitization each time a Rh negative woman is transfused with Rh positive blood, the result on future pregnancies may be disastrous.

Citrate intoxication. This has been mentioned above (p. 606).

VITAL STATISTICS

VITAL statistics are those relating to population, births, marriages, deaths and sickness. They are of interest in themselves, but also are essential for planning—political, social and medical. It is a function of government and of individual doctors to see that proper provision is made for services to their patients both collectively and singly. For this provision, planning is needed and such planning must be based on adequate statistics. Statistics may be collected at national, regional, hospital and other levels of organization. Doctors in hospital or in general practice compile statistics of their work so that it may be compared with that of others, to keep a check on progress and discover where further efforts are needed. The object of this chapter is to provide some basic information on the nation-wide statistics for England and Wales, against which other statistical samples of smaller populations may be judged.

Vital statistics are also valuable in that they extend the personal experience of any one obstetrician, indicate the trends of events over the years, draw attention to areas where more effort is needed to improve results, and show where more information is needed, as well as being the starting material for much research.

The collection of statistics

All births, marriages and deaths are eventually notified in England and Wales to the Registrar-General. From these notifications the Registrar-General is able to compile statistics which are regularly published. In addition every ten years a National Census is taken.

More will later be said of the Reports on Confidential Enquiries into Maternal Deaths in England and Wales compiled annually by the Ministry of Health, and of the Perinatal Mortality Survey of 1958 which was organized with the aid of the National Birthday Trust Fund and included Scotland with England and Wales.

Most maternity hospitals compile their own statistics, often in a standard form recommended by the Royal College of Obstetricians and Gynæcologists. These may or may not be published for comparison with results obtained elsewhere, but even when they are not published they are of interest to those concerned as a guide to what they are doing and the value of their practice.

There are many other sources of statistics, each valuable in their own particular way, but only national and some regional statistics relating to obstetrics can be dealt with here.

In this country the average number of children per family is about 2·3. The number of 2·3 children per family more than replaces the population, even allowing for those who do not marry and those who are infertile.

Birth rate

From the Registrar-General's returns the total number of births in a given time can be found. The total number must include both live births and stillbirths (by convention only births occurring after the 28th week of pregnancy are included). The *crude birth rate* is the number of live births per 1,000 total population. Since this population includes men, children and women beyond childbearing age it is better to relate the live births to the numbers of women between the ages of 15 to 44. This is done in the *fertility rate* which is the number of live births per 1,000 women of these ages.

For population statistics it is obvious that the stillbirths are of no interest as they do not contribute to the population, but to the obstetrician the number of stillbirths is a measure of the value of the maternity services. *The stillbirth rate* is defined as the number of stillbirths per 1,000 total births (both live and still). This shows the wastage of fœtal life during pregnancy and labour out of every 1,000 pregnancies that pass the 28th week. Further wastage of life occurs in the first few weeks after delivery. The neonatal period is the first 28 days of life and the *neonatal mortality rate* is defined as the number of babies dying in this period per 1,000 live births. The *infant mortality rate* is defined by the number of infants dying after the neonatal period and before completion of one year of life per 1,000 live births.

The stillbirth rate measures the losses from all pregnancies up to the time of birth, and therefore is related to *total* births; the neonatal mortality rate is a measure of those born alive and dying before the end of the first four weeks and so must be related only to *live* births. The infant mortality rate similarly can only be related to live births.

Fairly recently it has been recognized that causes of death which are operative during pregnancy and labour may project their ill-effects into the first few days of life. Therefore the concept of perinatal mortality has arisen, in which stillbirths are aggregated with deaths in the first week of life. The *perinatal mortality rate* is defined as the number of deaths occurring in pregnancy (after 28 weeks) plus those in the first week of life per 1,000 total births. This is largely a measure of deaths due to obstetric causes, whilst death in the last 3 weeks of the neonatal period are more often due to pædiatric causes, and this is even more true of the deaths in the ensuing 11 months. Of course so-called 'obstetric' causes of death may be operative in the neonatal and infant periods, and 'pædiatric' causes may be

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operative in the first week of life, but the partial separation of these two groups of causes is valuable.

The number of births per annum has been steadily increasing for some time and so has the birth rate. Table I gives some of the recent relevant data. A graph (Fig. 226) shows the trends in Infant and Neonatal Mortality from 1906 to 1956. From this it will be seen that whilst infant mortality has greatly declined, largely as a result of the better treatment of infections, neonatal mortality has not declined at anything like the same rate.

TABLE I

ENGLAND AND WALES: BIRTHS AND STILLBIRTHS, AND DEATHS OF INFANTS, 1936-62
(Taken from the Annual Report of the Chief Medical Officer of the Ministry of Health for the Year 1962).

Year	Births		Stillbirth rate per 1,000 total births (live and still)	Neonatal mortality rate per 1,000 live births	Infant mortality rate per 1,000 live births
	Live births				
	Annual number	Rate per 1,000 living			
1936-40	608,330	14·7	38·5	29·2	55·3
1941-45	669,269	15·9	30·5	26·0	49·8
1946-50	780,933	18·0	24·0	21·1	36·4
1951-55	675,420	15·3	23·0	18·0	26·9
1956	700,335	15·7	22·9	16·8	23·7
1957	723,381	16·1	22·5	16·5	23·1
1958	740,715	16·4	21·5	16·2	22·5
1959	748,501	16·5	20·8	15·9	22·2
1960	785,005	17·2	19·8	15·5	21·8
1961	811,281	17·6	19·0	15·3	21·4
1962	838,736	18·0	18·1	15·1	21·7

Table I shows that the number of births per annum rose steadily during the war to reach a peak in 1946–50. The number then fell off sharply but has since risen steadily every year. The drop in births after the war and the steady rise since are still largely unexplained. It is not yet possible to say whether the present rise will continue and if so for how long. In unsophisticated areas of the world where no contraception is practised the crude birth rate is of the order of 40 to 50 births per 1,000 total population, against which figure that of England and Wales looks small. The difference between the two rates is an expression of the use of contraceptive methods of all kinds. In the backward relatively uncivilized communities the total population does not rise at any greater rate than that of the more advanced countries, because with the backwardness go high stillbirth, neonatal, and infant mortality rates as well as a high death rate. When these are all at a low level due to social factors, of which medicine is

important but not the only one, the reaction appears to be a wider use of contraceptives, a lower birth rate and smaller families in the knowledge that most children born alive will survive to maturity.
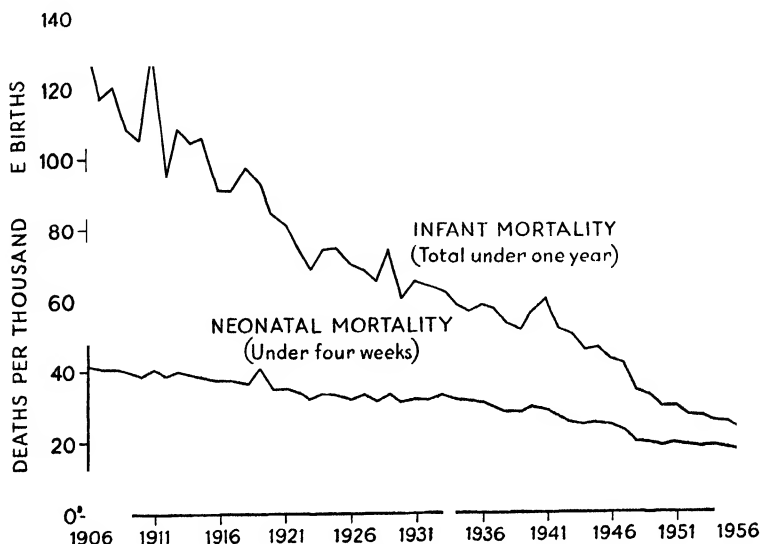
FIG. 226.

Stillbirths

In 1962, the most recent date for which accurate figures are available, of every 1,000 pregnancies reaching the 28th week about 18 ended in stillbirth. From Table I it will be seen that great progress has been made over the last 25 years during which time the stillbirth rate has been more than halved. There was a rapid fall from 1938 to 1950, since when there has been a further steady but less rapid fall. The reasons for these varying rates are to be sought in a closer analysis of the causes of stillbirth.

Table II shows some of the main causes of stillbirth in cases in which the baby was legitimate. The stillbirth rate is higher when the baby is illegitimate.

These figures, show where effort must be directed in order to lower the stillbirth rate. That it can be lowered is shown by the better figures that come from some other countries. Toxæmia of pregnancy is still the largest cause of stillbirth, as it has been for some time past. Stillbirths from this cause have been steadily declining over the last few years, probably because it is now safer to deliver babies at earlier times in pregnancy than heretofore. Induction of labour has become more sure with the use of artificial rupture of the membranes and the administration of intravenous oxytocics.

Such induction is more readily undertaken because if it fails Cæsarean section can be more safely done because of better anæsthesia, blood transfusion, knowledge of electrolyte balance and antibiotics. Added to these obstetric factors is the better care of premature babies of recent years, which allows the obstetrician to terminate the pregnancy earlier and so to save the baby from the effects of continuing pre-eclamptic toxæmia. It is clear that though this policy is successful the returns from it cannot indefinitely be improved, for if more and more earlier deliveries are effected more babies will die of prematurity. This only shifts the deaths from one column to another.

TABLE II

LEGITIMATE STILLBIRTHS BY CAUSE

(Taken from the Annual Report of the Chief Medical Officer of the Ministry of Health for the Year 1962).

Major causes of stillbirth	Number	Rate (per 1,000)
All causes	14,175	17·8
Toxæmia of pregnancy including eclampsia	1,991	‚2·5
Hæmorrhage and premature separation of the placenta	1,527	1·9
Anencephalus	1,452	1·8
Cord conditions	1,146	1·4
Maceration	899	1·1
Hydrocephalus	694	0·9
Erythroblastosis	647	0·8
Difficult labour with malposition	526	0·7
Spina bifida	465	0·6
Chronic disease in the mother	424	0·5
Birth injury	355	0·4

The readier recourse to Cæsarean section undoubtedly saves babies from asphyxia due to placenta prævia and other causes of premature separation of the placenta, but deaths from accidental hæmorrhage of all kinds still cause many stillbirths. Prevention of premature separation is obviously the ideal rather than to attempt to save the fœtus after the separation has occurred. The possible role of folic acid in aiding proper embedding of the placenta may be a pointer to future progress, but other lines of investigation and treatment may be rewarding.

As other causes of stillbirth are diminished the relative importance of developmental anomalies of the central nervous system increases. In the Table anencephaly, hydrocephaly and spina bifida together account for 3·3 stillbirths per 1,000 total births, which is more than those attributable to pre-eclamptic toxæmia.

Cord conditions together with difficult labour and birth injury account for 2·5 stillbirths per 1,000 total births. In theory all these causes of stillbirth are susceptible to obstetric treatment, and improved care might help to reduce this figure.   •

The ultimate cause of intra-uterine death is some degree of placental insufficiency. There are many causes of this but toxæmia, hypertension, chronic nephritis and possibly chronic pyclonephritis are all known causes. Other causes need more research for their elucidation. In cases of rhesus iso-immunization research is now being directed to the suppression of the formation of antibodies.   •

The heading in the Table of chronic disease in the mother is a reminder that successful childbearing is dependent upon the previous health of potential mothers from birth to maturity. It is not purely a matter of the nine months of pregnancy but of the whole previous life, upbringing, nutrition and health.

Neonatal mortality, and perinatal mortality

The neonatal mortality rate is the number of deaths per 1,000 live births occurring in the first month of life. As has already been pointed out the causes of death in the last 3 weeks of this time are on the whole different from thóse of the first week. Therefore of recent years it has become customary to divide deaths of fœtuses and of infants in the first week of life from those deaths occurring in infants aged 1 week but under the age of 1 year. These two divisions are called *perinatal mortality* and *later infant mortality*. In general perinatal mortality is attributable to obstetric causes and later infant mortality to pædiatric causes. The *perinatal mortality rate* is the number of stillbirths and deaths under 1 week per 1,000 total births. The *later infant mortality rate* is the number of deaths of infants aged 1 1 week but under 1 year per 1,000 total births. It should be noted that this last figure is related to total births and not to live births.

The following tables (III and IV) show perinatal mortality rates and later infant mortality rates, and also the causes of infant deaths between the ages of 4 weeks and 1 year.

It can be seen from Table III that great headway has been made in the saving of infant life in the perinatal period, but this was to be expected from the separate figures for still births. From the years 1951 to 1958, however, the stillbirth rate was almost stationary whilst the perinatal mortality was falling more steeply, so hinting that some change in the numbers of deaths of babies in the first week of life was taking place at this time. Table IV suggests a possible reason for this in the steep fall in infant deaths due to infections and gastro-enteritis in the years from 1951 to 1958. As might be expected the number of deaths from congenital malformations has not altered.

The main killing diseases of the first week of life are asphyxia, intra-cranial hæmorrhage, prematurity, congenital abnormality, and infection. Of recent years infection has been largely controlled by the introduction of the antibiotics and chemotherapeutic agents. Deaths due to intra-cranial hæmorrhage can partly be reduced by still better intrapartum care.

TABLE III

PERINATAL MORTALITY AND LATER INFANT MORTALITY PER 1,000 TOTAL (LIVE AND STILL) BIRTHS

(Taken from the Annual Report of the Chief Medical Officer of the Ministry of Health for the Year 1962)

	1931	1941	1951	1958	1959	1960	1961	1962
Stillbirths and deaths under 1 week per 1,000 total births	62·1	54·7	38·2	35·0	34·1	32·8	32·0	30·8
Deaths of infants aged one week but under 1 year per 1,000 total births	42·4	37·7	14·0	8·5	8·5	8·3	8·0	8·5

TABLE IV

CAUSES OF INFANT DEATHS BETWEEN THE AGES OF FOUR WEEKS AND ONE YEAR
(rate per 100,000 live births)

(Taken from the Annual Report of the Chief Medical Officer of the Ministry of Health for the Year 1962)

Cause	1951	1958	1959	1960	1961	1962
Infective and parasitic diseases	97	23	23	19	21	18
Bronchitis	63	44	49	43	36	45
Pneumonias	372	197	197	214	198	220
Gastro-enteritis	109	32	34	38	40	47
Congenital malforma-tions	155	169	170	165	164	162
All other causes	302	171	161	150	151	168
All causes	1,097	637	634	628	610	659

Prematurity is still a largely unsolved problem. Asphyxia, which includes atelectasis and hyaline membrane disease, is difficult to control but seems to be responding to better methods of resuscitation at birth and improved care in the nursery. Congenital abnormalities still resist efforts to prevent them except in such diseases as rubella, and unfortunately doctors even

contributed to this cause of death in the thalidomide tragedy of 1962, when the drug thalidomide was found to be responsible for an outbreak of major congenital anomalies.

The Perinatal Mortality Survey of 1958

Under the auspices of the National Birthday Trust Fund a survey of all the births occurring in England, Wales and Scotland during one week of March 1958 was made. Virtually all the births together with relevant obstetric data were documented and analysed. In addition a survey of all the stillbirths occurring in the 3 months from March was made, and post-mortems were carried out on about 7,000 stillbirths by pathologists skilled in foetal and neonatal pathology. During the week of March there were about 17,000 births.

The Perinatal Mortality Survey is a mine of information and it is not possible to do it justice in a brief summary, and only a few points from it can be mentioned here. Certain groups of women are especially in danger of losing their babies and therefore need extra special care from all who are concerned with mothers' welfare. The maternity services of this country are run by three main parties, the hospitals, the general practitioners and the domiciliary midwives employed by local authorities. The Perinatal Mortality Survey showed where some of the shortcomings were in 1958 and by implication suggested the remedies, and at the same time it showed there were some unusual problems which had not been fully recognized before.

The following are some of the findings of the Survey:

Region. The perinatal mortality is greater in the north and west than in the south-east, and least of all in East Anglia and nearby. Several factors may contribute to the regional variations. The women of one area may be of better physique than those of another or of different social class distribution, or there may be more women of higher parity in one place than another. More hospital beds may be available in one region than another or communications may be better. In part this difference was found to be due to a higher incidence of congenital abnormalities in some regions than in others.

Height. Height may be taken as a crude index of physique of the mother. It is a compound of her genetic inheritance and her nutrition, interpreted in its widest sense, during her growth period. If the average perinatal mortality is taken as 100, then it is found that in women over 65 in. in height it is 79, in women of medium height 92 and in women under 62 in. in height it is 114. Taller women are likely to have larger bony pelves than shorter ones, but they may also provide a better intra-uterine environment because of their better physical development. Height cannot in general be divorced from social class.

Social class. For many years the Registrar-General has divided the total population into five major social classes. There are many pitfalls in such a simple classification but useful conclusions may be based on it. The class divisions are:

1. Professional and managerial.
2. Supervisory.
3. Skilled workers.
4. Intermediate—semi-skilled workers.
5. Unskilled workers.

The classes are graded partly on the basis of responsibility at work and on income, but in some measure they also define differences in ways of living. As between the groups there will be differences in housing, nutrition, education, age at marriage, leisure pursuits, spacing of children, use of social services of all kinds, but in the present context, especially of the maternity services. These differences are reflected in the stillbirth, perinatal, neonatal, infant and later mortality rates.

Age and parity. Still taking the average perinatal mortality as 100, it was shown that the loss of babies varies with the age of the mother. The mortality ratio is 107 under the age of 20, 87 at ages from 20 to 24, 86 at ages from 25 to 29, 107 at ages 30 to 34, 136 at ages 35 to 39, 200 at ages 40 to 44, and 254 at ages over 45.

Using the same mortality ratio the risk of losing the baby in the first pregnancy is 106, though the risks are relatively higher with rising age and in the under twenties. The risk is least with the second baby (74) and third baby (99), especially when the mother is between the ages of 20 and 30. With subsequent increase in parity the mortality rises progressively to reach 138 in the fourth pregnancy and 170 in the seventh.

The results will usually be best with women over 65 in. in height, of social class 1 or 2, having their second or third babies between the ages of 20 and 30. The results will be at their worst with small women, those of social class 4 and 5, those over the age of 30 (and especially 40), and those having a fourth or subsequent baby. Although all the evidence has not been given here it is obvious that those who need the best that the maternity services can offer are those in the high risk groups. Usually the best care for these will be in specialist hospital units, as both the Perinatal Mortality Survey and the Confidential Enquiries into Maternal Deaths in England and Wales have shown. In practice therefore the following groups of women must be booked for hospital antenatal care and delivery, quite apart from any other indication for this. They must be so booked *even if everything else seems to be in their favour*.

1. Mothers under the age of 20 and those over the age of 30.
2. Women having their first and those having their fourth and subsequent babies.

3. Women under 62 in. in height.
4. Women of social class 4 and 5.

Only with a booking policy based on these groups, as well as those who need to be booked because of obstetric abnormalities, is there any likelihood of lowering the perinatal mortality rate further. In 1962 it was 30·8 per 1,000.

Criticisms of obstetric care in 1958

The Perinatal Mortality Survey looked into some aspects of obstetric care, and some of the facts discovered were disquieting. The following is a brief summary of what was found.

Only 40·9 per cent of the population were booked for hospital delivery. 36·1 per cent were booked for home confinement and the rest in General Practitioner units. Since some cases had to be transferred from their homes and G.P. units to hospital, 49·1 per cent ultimately came under hospital care. Despite the fact that hospitals take high risk cases the mortality in the perinatal period in hospitals was not higher than the national average. Almost 1 in 4 of all women booked for confinement at home had to be transferred to the hospital service and this emphasizes the need for having all patients at risk booked by hospitals right from the start. It has been emphasized that the babies of women having their fourth or subsequent pregnancies are at high risk and yet less than 30 per cent of those having their fifth or later baby were booked and delivered in hospital. The number of women from social classes 1 and 2 who had their babies in hospital was out of proportion to their numbers in the childbearing population— that is, those at least risk used the hospital service most.

About 0·6 per cent of the population had no antenatal care at all and the perinatal mortality in this group was five times the national average. Although general practitioners and midwives working together in domiciliary practice had an unduly high proportion of patients from social classes 4 and 5 to look after, the perinatal mortality was least with them, therefore in general the case selection for home or hospital delivery is well exercised by them. But there is no room for complacency in any branch of the maternity services. One-third of all women in 1958 had no hæmoglobin estimation in pregnancy; one-sixth did not have the blood pressure recorded at every visit; one in 20 did not have her blood rhesus type tested, nor was it known before labour, and in one-third of all the perinatal deaths due to rhesus incompatibility the rhesus factor of the mother was not known.

It is evident that antenatal and intranatal care in 1958 had not been brought to any standard nearing perfection. Great and unremitting vigilance is needed in antenatal care, and there is no doubt that it is rewarded by the lowering of perinatal mortality.

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Causes of stillbirths and neonatal deaths

The Perinatal Mortality Survey had an unrivalled amount of material from which to draw conclusions and Table V shows some of the findings.

Congenital malformations are forming a larger and larger proportion of all perinatal deaths, as other causes of death are reduced.

Rhesus incompatibility cries out for more care in its management, and research to find some method of suppressing the formation of rhesus antibody formation in the mother, or some means of preventing these antibodies from reaching the fœtus.

TABLE V

Primary necropsy finding	Perinatal mortality rate per 1,000	Percentage of all stillbirths	Percentage of all deaths in the first week
Congenital malformation	5·8	17·5	21·6
Rhesus isoimmunization	1·3	4·4	4·2
Ante-partum death, no major lesion	3·4	17·0	—
Antepartum anoxia	3·4	17·4	—
Intrapartum anoxia	7·1	30·8	8·7
Intrapartum anoxia + cerebral birth trauma	2·1	7·8	5·3
Cerebral birth trauma	1·0	1·7	5·6
Pulmonary infection	1·5	—	13·3
Hyaline membrane	1·6	—	15·0
Massive pulmonary hæmorrhage	0·6	—	5·9
Intraventricular hæmorrhage	0·7	—	6·4
Early neonatal death—no histological lesion	1·0	—	8·7
Remainder	1·3	3·4	5·3
No necropsy	2·4	—	—
Total	33·2	100%	100%

Seventeen per cent of all stillbirths are due to antepartum anoxia for which no cause can as yet be found. Nearly 9 per cent of mature stillbirths have no apparent cause but anoxia. Anoxia during labour accounts for about 31 per cent of all stillbirths, and 41 per cent of the mature ones and nearly 9 per cent of the early neonatal deaths. These anoxic deaths are added to if there is associated cerebral trauma. Here is a major area for effort and research. Better methods of recognizing fœtal distress are badly needed and perhaps a readier recourse to Cæsarean section. Knowledge of uterine and fœtal blood flows might give some hint of the causes of anoxia, but nothing is yet known about them in labour. There are many causes of cerebral trauma, but especially in cases of disproportion of minor degree and in operative obstetrics careful selection of patients and better training in obstetric practice might be expected to help.

Respiratory distress caused by pneumonia and hyaline membrane formation needs better diagnosis and treatment. Hyaline membrane causes almost 25 per cent of early neonatal deaths in premature infants, so that prevention of prematurity is most desirable. The Perinatal Mortality Survey drew attention for the first time to the relative importance of massive pulmonary hæmorrhage. The cause of this is still unknown, and research is required in all this field.

Prematurity

A premature baby is defined as one weighing less than $5\frac{1}{2}$ pounds or, 2,500 grams at birth. Prematurity is a major factor contributing to neonatal death and it has appeared in many places in the foregoing survey of vital statistics. The incidence of prematurity is about 7 per cent of all births. It varies with social class being least in social class 1 and highest in social class 5. The survival rate of premature babies varies with the weight, and the best that can be expected is 21 per cent survival with weights under 1,000 g., 68 per cent with weights from 10001 g. to 1,500 g., 90 per cent with weights from 1,501 to 2,000 g., and 96 per cent with weights from 2,001 to 2,500 g. Needless to say survival rates are often below these figures. .

MATERNAL MORTALITY

In the nineteenth century the number of deaths of women due to childbearing was appalling. As many as 10 per cent of such women might die of puerperal sepsis alone. Many more died of disproportion and other complications of labour. Even in 1928, when the first survey of England and Wales was made, for every 1,000 births 4·28 women would die; that is to say any woman embarking on a pregnancy had a 1 in 250 chance of dying. With such dreadful results it is not surprising that the first task of obstetricians was to make childbearing safer for women, and the fate of the fœtus was of secondary consideration. Of recent years the maternal mortality has fallen to such low levels that it is no longer so meaningful as it once was as an index of obstetric failure and success. This is why so much attention has been given of late to stillbirths, perinatal mortality and neonatal death. Nevertheless every maternal death in a civilized country is a major tragedy, and the fact that relatively few women now die of causes associated with childbearing does not diminish its great importance for everyone who practises obstetrics.

The sources of information about maternal deaths in England and Wales are derived from the Reports on Confidential Enquiries into Maternal Deaths. When a woman dies when she is or has been recently pregnant, the local Medical Officer of Health sends a detailed questionnaire to be filled

in by the doctor who has had charge of the woman. Any midwives or nurses having knowledge of the death also write their reports. At no time is the identity of any person connected with the medical and nursing care of the

TABLE VI

ENGLAND AND WALES: OUTCOME OF PREGNANCIES

Year	Total (live and still) births	Maternal mortality from childbearing					Maternal mortality from abortion.			
		Deaths	Death rate per 1,000 births				Deaths	Rate per 1,000 births	Rate per million women aged 15–44	
			Infections	Others	Total				Septic	Other
1951	693,514	419	0·10	0·50	0·60		107	0·15	7	4
1958	757,003	265	0·07	0·28	0·35		63	0·08	4	3
1959	764,402	243	0·06	0·26	0·32		47	0·06	3	2
1960	800,824	248	0·04	0·27	0·31		62	0·08	3	3
1961	827,008	220	0·04	0·23	0·27		54	0·07	4	2
1962	854,200	242	0·05	0·23	0·28		57	0·07	3	3

patient disclosed, and because of this each person giving evidence on the death may be completely frank and unbiased and no one filling in this kind of form need fear any recriminations of any kind from anybody. •

After the form has been filled in it is sent to assessors who are senior obstetricians of standing who write down their opinion as to the cause of death. In doing this they try to decide if the death was 'avoidable' or 'unavoidable'. These terms are not meant to imply criticism of those concerned with the case but merely to ask whether the woman, her family, the

TABLE VII

ENGLAND AND WALES: CAUSES OF DEATH ASCRIBED TO PREGNANCY AND CHILDBIRTH

(Number of cases)

Cause of death	1951	1958	1959	1960	1961	1962
Toxæmia of pregnancy	126	58	50	60	46	50
Antepartum hæmorrhage	8	9	3	1	2	4
Ectopic pregnancy	21	13	12	17	12	22
Other complications of pregnancy	19	21	28	20	20	26
Abortion with sepsis	67	35	29	33	32	28
All other abortion	40	28	18	29	22	29
Antepartum hæmorrhage complicating delivery	27	16	18	24	18	19
Postpartum hæmorrhage	53	33	23	19	23	20
Other deaths from delivery	77	47	48	65	54	47
Puerperal phlebitis, thrombosis and pulmonary embolism	49	40	30	27	24	34
Other sepsis of pregnancy, childbirth and puerperium	16	13	17	8	6	12
Puerperal toxæmia	15	8	7	3	9	3
Other complications of puerperium	8	7	7	4	6	5
Total	526	328	290	310	274	299
Total excluding abortion	419	265	243	248	220	242

doctor and the midwife and anyone else concerned had made the fullest possible use of all available services and help. If there have been shortcomings in the use of services or administration, or if the standard of professional care was lower than should be expected, then the death is classed as 'avoidable'. This is not to say that it could have been avoided, only that some factor was present which if foreseen might have made the outcome different. The results of these enquiries are published at three yearly intervals.

Tables VI and VII, taken from the Annual Report of the Chief Medical Officer of the Ministry of Health for the Year 1962, are summaries of the Confidential Reports.

The first point to note is that deaths from childbearing are separated from

those due to abortion. This is why Table VI is divided into two sections. The deaths from abortion have scarcely declined at all in the last 5 years to 1962, though between 1951 and 1958 the septic abortion deaths fell by almost half, presumably because of the wide use of antibiotics. Criminal interference is the main cause of serious illness in cases of abortion. It has been computed that about 10 per cent of all pregnancies are ended criminally, which means that there are between 200 and 300 abortions criminally performed in England and Wales every day. Seen against this background 28 deaths every year from abortion with sepsis is perhaps not very great, but it might be better to try to remedy the social causes which induce women to procure abortion upon themselves or get others to do so.

From the total deaths excluding abortion it will be seen that the numbers of women dying every year is staying much the same, but this has to be viewed against the rising birth rate, so that the maternal mortality rate per 1,000 births is very slowly declining. In the last 25 years the chances of a woman dying as a result of childbearing have declined from about 1 in 250 to about 1 in 4,350. This is largely due to control of infection and hæmorrhage, together with a readier recourse to operative obstetrics which has been made safer by advances in anæsthesia and resuscitation. Nevertheless there is still room for improvement, as a closer look at the causes of death will show.

Toxæmia of pregnancy as a cause of death has declined over the years, but in the Confidential Report for 1958–60 there were still 137 deaths, and avoidable factors were thought to be present in 56 per cent of them. In 24 of the 77 avoidable deaths the patient or her relatives were primarily at fault in not seeking proper care, but consultants, general practitioners and clinic medical officers had all showed lapses in care in the remainder.

Hæmorrhage at all stages of pregnancy, during labour and in the puerperium caused 130 deaths from 1958 to 1960 and in 53 per cent of these it was thought that there had been an avoidable factor. Again there were relative failures in different cases by all concerned, consultants, general practitioners, clinic medical officers, midwives, and the patient and her relatives. Particularly it was found that patients of high risk were wrongly booked to have their babies at home or in poorly equipped institutions when they should have been in hospital. Older women, those of high parity and those with a previous history of postpartum hæmorrhage should all be cared for in hospital.

Pulmonary embolism is still a big problem. It featured in 132 cases in 1958–60, and of these 30 were in pregnancy whilst the rest followed vaginal delivery or Cæsarean section. There was no consistent pattern to be discerned in these deaths and in only one was there an avoidable factor. Research is sadly needed here, for these deaths are so sudden and come without warning.

Cardiac disease of all kinds caused death during childbearing in 66 women in 1958–60. All pregnant cardiac patients must be cared for in hospital. Cæsarean section is particularly dangerous and should be avoided as far as possible.

Cæsarean section is by obstetric standards a relatively hazardous procedure for the mother. From 1958–60 there were 130 deaths following the operation, giving a mortality of about 2 for every 1,000 operations performed. It should be remembered that the cause of death may not be entirely ascribable to Cæsarean section. Some of the blame must be taken by the reason for performing it. Nevertheless it has been shown that a woman's chances of dying as a result of childbearing are in the region of 1 in 4,000 and these odds shorten to 1 in 500 if she has to have a Cæsarean section, that is an eightfold increase.

Other causes of maternal death were anæsthesia and a variety of intercurrent diseases. As other causes of death have become less common these are relatively more significant. Deaths from anæsthesia are often due to inhalation of vomited material in women who are incompletely prepared for anæsthesia for some obstetric emergency. It is essential that a fully trained anæsthetist with adequate equipment should be responsible for such cases, and that patients in labour should only be given bland fluids or sieved food. Whenever possible local anæsthesia, such as a pudendal block, should be used.

Deaths from intercurrent disease, such as cardiac disease, can be much reduced by proper antenatal medical treatment, to which reference is made on p. 269.

The Confidential Report drew especial attention to the following points:

1. Grave errors had often been made in booking unsuitable patients for home confinement.
2. Antenatal care had often been deficient, especially in watching the progress of pre-eclampsia at home, when the patient should have been in hospital.
3. The seriousness of delay in the first stage of labour had not been fully recognized, the dangers being those of sepsis, obstructed labour, and electrolyte and water imbalance.
4. There had been some attempts to effect delivery of the patients by forceps and other manipulations in places other than hospital. These may cause severe shock and render subsequent Cæsarean section more dangerous than it otherwise would have been.
5. Too often, especially when operating on account of antepartum hæmorrhage too little attention had been given to restoring the blood volume by transfusion.

This has been a very brief survey of vital statistics mainly pertaining to England and Wales. Comparisons with other countries are of interest but cannot be considered here. Vital statistics have implications for government, administration, maternity services, consultants, general practitioners, midwives, and local authorities, to name only a few. But statistics are not only for planning at a theoretical level; they are important guides to the actions of individual doctors in their obstetric practice. Obstetric statistics are only the aggregate outcome of thousands of individual actions and each one of us has power to alter them for better or worse.

CARE OF THE NEWBORN INFANT

Up to the moment of delivery, the fœtus lives a parasitic existence. The placenta 'breathes, digests and excretes' for the fœtus and permits the vital functions of respiration and digestion to remain latent. Protection against trauma, infection and heat loss is afforded by the surrounding maternal tissues.

Survival and growth are dependent upon an intact placental circulation, but, at the moment of delivery, the infant is launched on an independent existence and must assume these vital functions or die. This necessitates profound physiological changes in the infant immediately following the traumatic experience of birth.

The first and most important alteration is in cardio-respiratory function while changes in the other bodily systems occur in a more leisurely fashion.

Changes in the respiratory system. It has been demonstrated that the fœtus *in utero* rehearses the movements of respiration to a point just short of expansion of the chest and lungs. These respiratory movements are phasic and are interrupted by long periods of rest. Amniotic fluid is drawn in and out of the nasopharynx and the bronchial tree during intra-uterine respiratory movements and this may assume great importance when extra-uterine respiration is initiated. It assumes especial importance when fœtal distress has occurred and meconium has been expelled into the liquor amnii.

It is uncertain what particular stimuli are responsible for the initiation of respiration after birth. Once labour has begun the uterine contractions probably produce a relative anoxia in the placental circulation.

With anoxia the fœtal respiratory centre first responds more actively to carbon dioxide, but with increasing anoxia the centre becomes depressed and the primitive gasping reflex is released. Respiratory movements are increased in each case, apparently as the result of stimulation but in reality as the result of depression of the centre.

Once the baby is born the body can uncoil from the fœtal position and the straightening of the spine and the change in shape of the chest and position of the diaphragm facilitate respiration. The fall in body surface temperature after delivery is probably an added stimulus to respiration.

Some combination of these factors is held responsible for the initiation of full respiration. It must be remembered that any sedative or anæsthetic administered to the mother is shared by the fœtus, and may depress the respiratory centre which is then less ready to respond to such stimulation.

In normal circumstances the first breath draws air into the bronchial tree and the lungs, unless there is obstruction from liquor amnii or mucus. With successive respiratory movements the thoracic cage expands and creates a negative intra-pleural pressure. The difference between this intra-pleural negative pressure and the atmospheric pressure of the air in the bronchial tree causes the solid fœtal lung to expand by entry of air into the alveoli. The walls of the unexpanded alveoli are held together by a thin layer of fluid, and the surface tension between the walls must be overcome before full expansion can be achieved. This may be a factor of importance in delay in expansion, and enzymes which reduce surface tension have been demonstrated in the lungs of newborn animals. Alveolar expansion is at first rapid, but several hours elapse before complete expansion of the lung occurs, especially at the lower lobes.

Although the first breath is usually taken immediately after birth, respiration may be suspended for many minutes. The newborn infant appears to be less susceptible to the ill-effects of prolonged anoxia than is the adult, but it is imperative that full oxygenation should be achieved as soon as possible, as deep anoxia lasting for only a few minutes may cause severe neurological damage and result in subsequent cerebral palsy or mental retardation.

Changes in the cardiovascular system. The fœtal circulation differs from that of the adult in several important respects.

Fœtal circulation (see also p. 41). From the placenta, fœtal blood receives oxygen and nutriment which is carried back to the fœtus by the umbilical vein. On entering the body of the infant the vein divides, one branch carrying blood to the liver and thence to the hepatic vein and inferior vena cava, while the other branch carries oxygenated blood directly to the inferior vena cava through the ductus venosus. Only a small proportion of the blood entering the right auricle from the inferior vena cava passes to the right ventricle and the pulmonary circulation, as the lungs require little blood in their unexpanded state. The main volume of blood passes from the right auricle to the left auricle through the foramen ovale and thence to the systemic circulation through the left ventricle. A second by-pass exists in the ductus arteriosus which deviates blood from the pulmonary artery to the aorta. These shunts or by-passes deviate blood from the unexpanded lungs and ensure a rich supply of oxygenated blood to the head and neck and to the remainder of the body. The hypogastric arteries arise from the internal iliac arteries and terminate as the umbilical arteries which carry de-oxygenated blood back to the placenta.

Changes in fœtal circulation at birth (see p. 42). The occlusion of the umbilical vessels and the onset of respiration cause functional changes in

the circulation which are followed after a variable interval by anatomical changes.

The umbilical cord desiccates and separates leaving a raw area which heals by granulation and is covered by epithelium. The umbilical vein is now a redundant vessel and closes by aseptic thrombosis. The ductus venosus atrophies and disappears, while the umbilical vein remains as the ligamentum teres. The umbilical arteries show retrograde closure as far as the hypogastric arteries and persist as sclerosed remnants.

The drop in pressure in the right side of the heart which is created by the expansion of the lungs and opening up of the pulmonary circulation is responsible for the obliteration of the foramen ovale. The same factors are probably responsible for the functional closure of the ductus arteriosus. This functional closure may be due to a valve-like action in the aortic wall or to a torsion of the ductus, but results in the separation of the systemic and pulmonary circulations. The ductus arteriosus is anatomically obliterated by endarteritis after one or two months, although the persistence of a patent ductus arteriosus is a not uncommon congenital cardiac malformation in adult life.

These changes in the fœtal circulation ensure that the total circulating blood passes through the lungs and is returned, fully oxygenated, to the left side of the heart to supply oxygenated blood to all tissues of the body.

Changes in the gastro-intestinal tract. Although it has been stated that the placenta digests and excretes for the fœtus, the gastro-intestinal tract is active during intra-uterine life. Liquor amnii contains lanugo, hair and epithelial cells shed from the fœtal skin. During the later months of pregnancy, liquor is swallowed by the fœtus. Mucus and debrided intestinal epithelium are added to the gut content and, with the swallowed liquor, are digested by intestinal ferments to create meconium. The greenish black colour of meconium is due to bile pigments. The meconium has traversed the gut as far as the rectum by late pregnancy, and, if strong intestinal contractions are stimulated during labour by fœtal distress, and the sphincters are atonic or paralysed, meconium may be voided into the amniotic fluid. This may cause respiratory difficulties if premature respiration is also induced, and meconium-containing liquor is inhaled into the bronchial tree.

With the first inspiration, air enters the stomach and rapidly traverses the gut, reaching the ascending colon within 3 hours.

The hydrochloric acid content in the stomach is relatively high on the first day of life, but is present in only moderate amounts during early infancy.

Amylase from the salivary secretion and from the pancreas is at a low level during the early weeks of life, and this explains the difficulty in digesting starch which may be met in some infants.

The trypsin and lipase of pancreatic secretion are present in good concentration, even during intra-uterine life, and are responsible for the digestion of meconium.

The genito-urinary tract. The removal of fœtal metabolic end products is achieved mainly by the placenta. The kidneys are active, however, during the later months of pregnancy and urine is excreted into the amniotic fluid. Obstructive anomalies of the urinary tract may produce hydronephrosis which is demonstrable at birth.

Regulation of the body temperature. The fœtal temperature is probably dictated by the temperature of the surrounding maternal environment, and control by the infant's heat regulating centre is dormant. After birth, unless special precautions are observed, the infant's temperature falls by 2° to 5°F and external heat must be supplied. After a few days the temperature regulating centre becomes effective and the infant's temperature is kept normal despite environmental variations in heat.

Defences against infection. Placental transmission of antibodies present in the maternal serum affords the infant a non-specific passive immunity against certain diseases. This immunity wanes after a short period, and the infant is at risk from common infections until an acquired immunity is developed. The immunity may be specific against infectious diseases from which the mother has suffered, and against which she has developed an active immunity such as diphtheria, tetanus, measles, mumps, smallpox and poliomyelitis. The newborn infant appears to receive little transplacental immunity to streptococci, staphylococci and coliform organisms and may show a special sensitivity to infection with these organisms and certain viruses. The infant does not provide his own γ-globulin until 2 or 3 months of age.

Causes of neonatal mortality. The causes of death within the first month of life may be classified under the following heads:

1. Congenital malformation incompatible with life, although some deformities are remediable by surgery.
2. Failure of adaptation of the infant to an independent existence. Cardio-respiratory adaptation of function is immediately urgent, but changes in other systems may be delayed.
3. Prematurity and immaturity, with the added hazards to the life of an individual not yet ready for independent life.
4. Trauma induced by the act of birth.
5. Failure to establish nutrition and normal digestion.
6. Infection.

The normal healthy infant spontaneously undergoes the physiological changes which permit independent life; and the immediate care of the newborn must be directed to encouraging these changes to take place, to remedying any factor which may prevent these adjustments, and to the appreciation and correction of any malformation or traumatic effect which will endanger the life of the infant.

The following paragraphs detail the care which is necessary for the healthy infant, and subsequent paragraphs describe the deviations from normal which may arise and the measures by which they should be corrected.

THE IMMEDIATE CARE OF THE HEALTHY INFANT

When the body is delivered, the infant may be limp, with only moderate muscle tone, and there is purplish blue cyanosis of a general distribution. Liquor drains from the nose and mouth, and to assist this drainage the
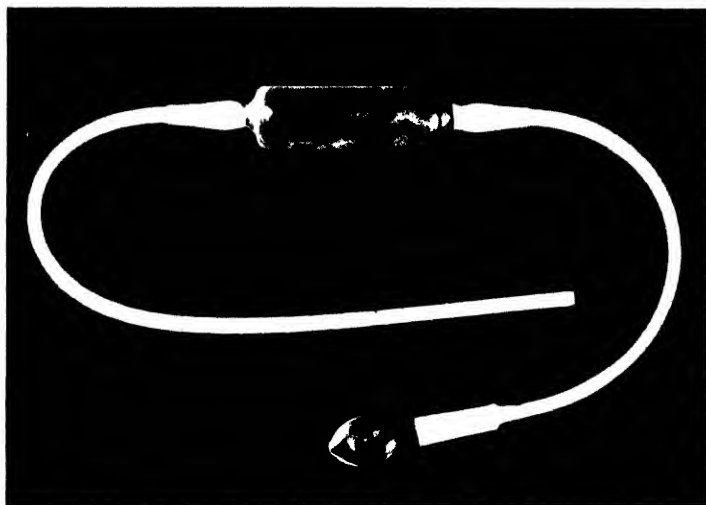
FIG. 227.   Catheter for the aspiration of fluid from the pharynx.

infant should be inclined head downwards with the arms extended above the head. The mouth should not be cleaned with gauze swabs as this will cause damage to the delicate buccal mucosa.

The nasopharynx should be cleared of fluid with a sterile mucus catheter. The type illustrated (Fig. 227) is made of rubber tubing with a glass fluid trap and mouthpiece. Metal mucus catheters should not be used, as the tip of the metal tube may damage the pharyngeal wall. The tubing must be made of soft rubber or plastic, and the catheter must include a

chamber to trap the aspirated fluid. This prevents the individual using the catheter from sucking the fluid directly into the mouth. The stomach of the newborn infant, especially when delivered by Cæsarean section, contains quite large quantities of amniotic fluid which may possibly be regurgitated later and inhaled. The stomach should be aspirated after the naso-pharynx has been cleared.

As soon as the nasopharynx has been cleared of liquor amnii and mucus the infant will normally take a breath and give a cry, and, as respiration commences, the colour of the skin rapidly changes from a deeply cyanotic to a pink colour. Cyanosis of the extremities may persist for a longer period, but this is not usually of pathological significance.

Care of the eyes. In the past it was the custom to instil one drop of 1 per cent silver nitrate solution into each eye after delivery as a prophylactic against conjunctival infection, especially gonococcal, in cases in which maternal infection existed. Most institutions have now abandoned this practice on the grounds that it is unnecessary and that the antibiotics offer a more efficient therapy which can be applied immediately if infection should occur. Silver nitrate solution may itself cause a non-specific irritation or cloudiness of the cornea. In other institutions penicillin eye drops (2,500 units per ml.) are used instead of silver nitrate solution and are instilled into the eyes immediately after birth.

The use of prophylactic drops is probably unnecessary unless there are special indications. Daily wiping of the eyes with wool soaked in normal saline is a common and undesirable practice which may predispose to a pyogenic conjunctivitis. The eyes of the newborn infant should not be treated unless infection occurs.

Ligation of the umbilical cord. The umbilical cord is clamped temporarily about 6 in. from the umbilicus and a pair of artery forceps applied a short distance away on the maternal end of the cord. The cord is cut between the ligature and the forceps and the end is covered with sterile wool. It is debatable whether the cord should be tied immediately, or whether ligature should be delayed until cord pulsation has ceased. Delay in tying probably increases the infant's blood volume by 30 to 60 ml. It is claimed that this umbilical transfusion is beneficial by increasing the store of iron reserves in the body, but it increases the number of red blood cells which are hæmolyzed during the first week of life and the likelihood of physiological jaundice.

The cord ligature is made of twisted stout linen thread or of nylon tape and it is tied with a reef knot. The ligature should be tight enough to occlude the blood-vessels, but should not cut the cord. A fleshy thick cord will rapidly shrink in diameter and the ligature will become loose. Non-slip

plastic clamps or metal clips may be used in place of a ligature, and it is claimed that their use reduces the risk of bleeding from the cord.

Examination of the infant. Inspection of the infant will reveal any gross congenital abnormalities. It is advisable to carry out this examination in a systematic fashion, beginning with the head and inspecting the whole surface of the body. The inside of the mouth should be inspected to detect a cleft palate. The anus should be examined to exclude imperforate or ectopic anus. Careful note must be taken of any birthmarks or nævi which are present, or supernumerary digits. Further points on the complete physical examination of the newborn infant are discussed on p. 632.

General care of the baby. The baby is wrapped in warm towels and blankets and placed head down in a crib tilted to an angle of not more than 15″. The baby is kept under observation and the air passages are sucked free of any further fluid which may come from the bronchial tree or the stomach. Continuous respiration and crying must be encouraged.

Once the respirations are well established, the baby may be shown to the mother. After the infant has been handled by the mother he should be returned to his cot and kept warm; needless exposure or handling may cause a fall in temperature. From time to time the cord should be inspected to ensure that shrinkage of the fleshy cord has not permitted the ligature to become loose, with risk of hæmorrhage from the cord.

The baby's bath. At birth the infant is covered with greasy vernix caseosa and blood. Vernix is difficult to remove with water, but comes off with olive oil applied on wool swabs. The baby is usually bathed after the first hour or two, and dressed after the cord has been treated. An antiseptic such as hexochlorophane may be added to the bath water and helps to reduce the incidence of skin infections in the nurseries of maternity units.

The first bath should be omitted if the infant is suffering from shock or trauma, or if his condition is not entirely satisfactory. No harm will result from this failure to remove the vernix, which will peel off within a few days without becoming offensive or infected. It is believed in some maternity units that daily bathing predisposes to skin sepsis and in these units the baby is bathed only on the day before discharge from hospital.

After the bath the baby's skin should be dried by dabbing with a soft towel, as any rigorous rubbing will damage the soft and moist skin. The baby should be weighed naked, and the weight, body length and head circumference are recorded.

After the bath the cord should be ligated for the second time. The ligature should be applied about $\frac{1}{2}$ in. from the umbilicus and the cord cut to a length of 1 in. The stump may be covered with cord powder and wrapped

in a linen dressing held in place by a binder. A simple cord powder is made of 3 parts of talc to 1 part of zinc oxide. A collodion seal has been used in place of cord powder. The raw end of the umbilicus is covered with collodion which dries and hardens, sealing the cut surface, but leaving the stump of the cord free to desiccate. The use of collodion obviates the need for a linen dressing and binder, which are often soaked with urine from the napkin, with risk of infection. The collodion seal renders a binder unnecessary to the great advantage of the infant, since the binder is only too frequently applied in such a way that it hinders and embarrasses abdominal respiration and the comfort of the infant.

A variety of other treatments have been recommended, including painting the cord stump with triple dye or hibitane tincture at the time of ligature and subsequently daily.

The stump of the cord desiccates and separates between the 4th and 11th days, usually on the 6th or 7th. The raw area of the navel heals by granulation and ingrowth of epithelium and leaves a puckered scar.

Identification. In institutions it is most desirable that the infant should be identified by some name tape or other mark of identity. This may be a necklet or lettered beads spelling the baby's name, or a piece of tape sewn round the infant's ankle or wrist with the name marked in indelible ink. Whatever the method of identification employed it is essential that every baby in a maternity unit should be identified in such a way that confusion between babies cannot arise.

Dressing the baby. After the bath the baby should be clad in a soft woollen vest, a napkin and a dress. Any shawl or blanket should at first be wrapped loosely around the infant to permit freedom of movement. The body temperature must be maintained for the first few hours by clothing and coverings, raised room temperature, or hot water bottles in the cot, carefully shielded from the infant. Subsequently, when the temperature regulating mechanism is active, the clothing and the room temperature must be adjusted to the needs of the baby, and in accordance with the atmospheric temperature. Socks and gloves may be added to the clothing when the baby is exposed to a normal room temperature.

Examination of the newborn infant. At the earliest convenient moment after the birth of the infant a systematic physical examination should be carried out. External examination is of great importance and attention should be given to the presence of minor congenital defects. Skin nævi, pre-auricular sinuses, branchial fistulæ, supernumerary digits and nipples should all be looked for and a careful note made of their presence. Defects such as hare lip and cleft palate, spina bifida and club feet may

escape notice if of minor degree, and especial attention should be given to possible omphalocœle, penile abnormalities, cryptorchidism and imperforate anus. The hips should be examined for undue mobility or the presence of a click which will suggest a congenital dislocation.

The skull should be palpated and the state of the sutures noted. The circumference of the skull should be recorded, together with the length and weight of the infant. Careful examination of the skull soon after birth may yield information the importance of which is only apparent at a later time. Widening of the sutures and an increase in the circumference of the skull may be found in cases of subdural hæmatoma or hydrocephalus, and an early diagnosis may only be possible because the state of the skull at birth has been recorded. Areas of softening or lacunæ in the parietal bones may be found, or an encephalocele.

The baby should be handled and the limbs moved to ensure that no fracture or paralysis is present.

Examination of the heart should be carried out with care, and the presence of cardiac bruits noted. The significance of any murmur may only become apparent after observation for several days. Palpation of the femoral pulses should always be carried out.

The chest may show signs of incomplete expansion or the persistence of moist sounds from inhaled liquor. These conditions are discussed on page 637.

Examination of the abdomen will usually reveal a liver edge just palpable below the costal margin, and the tip of the spleen is often palpable. In a well-relaxed infant the lower poles of the kidneys may be easily felt.

Normal reflexes present. Certain reflexes are normally only present in the newborn infant. The Moro reflex is a startle or concussion reflex elicited by banging the table on which the infant is lying. The baby makes movements of abduction and adduction, the legs are drawn up, the arms are brought together in an embracing gesture and the infant cries. This reflex is usually a symmetrical response and indicates normal neuro-muscular coordination. Variations from this response are seen when there is a nerve palsy, a fractured clavicle or long bone, or an intracranial lesion.

If the infant is touched on the area near the mouth, he will turn his head and try to suck the object which touches him. The 'sucking' or 'rooting' reflex is the manifestation of the instinct to feed. A 'grasp' reflex is seen when the palm of the hand or the sole of the foot is touched and is normal in the newborn infant.

Normal progress of the full time baby. During the first week of life the baby continues to adjust himself to his extra-uterine environment.

Traumatic effects such as the caput succedaneum, petechiæ or œdema disappear rapidly, and the baby begins to assume an infantile position instead of the attitude of uterine folding. The feet are less dorsiflexed and the hands less firmly clenched. The chest becomes less flattened and the head is moved freely. The cry is definite and begins to assume characteristics for hunger and pain.

Weight curve. There is loss of weight during the first 2 or 3 days of up to 10 per cent of the birth weight. After feeding is established the weight increases and will usually return to birth level by the 7th to 10th day. If this is not achieved it may indicate inadequate feeding, or some condition which is preventing normal progress.

Temperature curve. At birth the infant is thermolabile and the temperature may fall below 97°F. The infant responds well to the application of external heat, and within a few hours the full time infant stabilizes his temperature regulation. The rectal temperature shows a normal daily variation from 97° to 99°F.

Normal stools of the newborn infant. Meconium is normally passed within the first few hours of birth, but the passage of the initial meconium may be delayed for 12 or even 24 hours. Although this is not necessarily pathological, it demands observation as it may indicate intestinal obstruction. The first meconium stool is preceded by a plug of whitish mucus, and if this plug is large the passage of meconium may be delayed for 24 hours and the abdomen may show some distension.

In the next 2 or 3 days meconium is passed several times a day. Normal meconium is sticky, odourless and greenish-black in colour. After a few days 'changing stools' are passed, and these are non-homogeneous, thin, sour, slimy and yellowish-brown in colour. Undigested milk elements can often be seen in the stool.

Towards the end of the first week milk stools are seen. The stool of the breast-fed infant is smooth, pasty, slightly sour, acid, and mustard or golden brown in colour. The motion of the artificially fed infant is paler in colour, alkaline, pasty, and non-homogeneous.

Variation in bowel habit. The breast-fed baby may have the bowels open only once in the day, or have any number of stools up to 5 or 6 in the 24 hours, and yet be normal. The maternal diet may influence the baby's bowel habit as many aperient substances are secreted in the milk.

Passage of urine. The baby usually passes urine shortly after delivery, but micturition may not occur until 24 hours have elapsed, especially if the infant has voided urine just before or during delivery. The bladder may then become palpable and the genitalia must be examined to ensure that no congenital defect exists. Pressure on the abdomen will often stimulate micturition.

The urine may at first be dark in colour, but rapidly becomes colourless and of low specific gravity.

During the first day or two the napkin may be stained pink from the deposit of urates.

Neonatal mastitis. The breasts of infants of either sex may swell and become engorged during the first week of life. Milk (witch's milk) may be secreted, and the female may bleed from the uterus. These effects are due to maternal hormone transfer and require no treatment.

Skin. The colour of the skin soon changes from the ruddiness seen after birth to a paler hue. The skin often becomes dry and scaly as it dries out after the long intra-uterine immersion. Fissures and cracks may appear in the folds of the ankles and wrists, but respond to an application of cold cream or lanoline. The skin is delicate and may show miliæ or various non-specific rashes.

It is common to observe blotchy erythematous rashes on the trunk, limbs and face. The most common rash is erythema toxicum, which may become almost pustular. No treatment is required.

Sleep. After delivery the baby usually settles to sleep and for the next week or two falls asleep after feeds, wakening only to protest with hunger, discomfort or thirst.

VARIATIONS FROM THE NORMAL

Apnœa neonatorum (failure to establish respiration). If the infant fails to respond to nasopharyngal aspiration, and the onset of spontaneous respiration is delayed, prompt action is required. In the majority of these babies the heart rate is good, limb tone is present, and the failure to breathe is due to liquor or mucus blocking the respiratory tract, the respiratory centre being normally responsive. In other infants limb tone is poor or absent, the heart beat is slow or absent, and the respiratory centre is depressed by trauma sustained during delivery or by analgesics administered to the mother.

The Apgar score is often used to evaluate the physical status of the infant one minute after delivery and to estimate any improvement in the subsequent few minutes. An Apgar score of ten represents the infant in an ideal physical state. The lower the score, the worse is the condition of the baby and the greater the the urgency for active measures of resuscitation. (See Table.)

When respiration does not follow drainage and aspiration of the naso-pharynx, the infant should be stimulated by flicking the soles of the feet and

APGAR SCORE

Sign	0	1	2
Heart rate	absent	less than 100	more than 100
Respiratory effort	absent	slow, irregular	good, crying
Muscle tone	limp	some limb flexion	active
Response to stimulus (nasal catheter)	nil	grimace	cough, sneeze
Colour	blue, pale	body pink limbs blue	pink

passing by a catheter through the nose to the nasopharynx. Oxygen should be flowing through the catheter at one litre per minute. The nasopharynx should again be aspirated. Many infants will start breathing after these measures have been employed.

However, if the baby remains unresponsive at the end of 2 minutes, the larynx should be visualized by direct laryngoscopy and the larynx and trachea aspirated through a catheter. This will often remove the liquor or mucus obstructing the respiratory tract and the infant will gasp, breathe and cry and rapidly become pink. Intranasal oxygen should be continued until full colour is achieved and regular respiration and strong crying have become established.

If tracheal aspiration through the laryngoscope is unsuccessful in initiating respiration, a plastic or soft rubber endotracheal tube should be inserted into the trachea and oxygen administered in short puffs through a T-piece, by means of a bag connected to a manometer which ensures that the pressure in the bag is kept below 20 cm. of water. This will often improve the oxygenation of the baby and start respiration after a short time. When spontaneous respiration is seen the endotracheal tube is removed and nasal oxygen continued until the condition of the infant is completely satisfactory. At other times, especially with an initially low Apgar score or when the infant has been narcotized, it may be necessary to continue assisted respiration through the endotracheal tube for long periods.

Artificial respiration or mouth to mouth insufflation may be dangerous measures if performed too vigorously, and can cause a pneumothorax.

The use of drugs in stimulating respiration is often disappointing. When morphine derivatives have been given to the mother shortly before delivery the infant may show effects from the transplacental transfer of these drugs. N-allyl morphine (Nalorphine) may be used to counteract these effects, and

is administered to the infant through the umbilical vein (0·1 mg. per kg. of body weight in 2 ml. of normal saline). The drug is itself a respiratory depressant and must only be used to counteract the morphine derivatives.

Nikethamide (Coramine) 0·25 ml. or vanillic acid diethylamide (Vandid) 0·25 ml. may be given intravenously or sublingually as respiratory stimulants, but their effect is uncertain.

It is important that injections into the umbilical cord should be made directly into the lumen of the umbilical vein. Should these injections be given into the umbilical artery they may cause spasm and subsequent thrombosis within the vessel, which spreads in a retrograde direction to involve the internal or common iliac vessels. In rare instances this may cause gangrene of one or both lower limbs, or sciatic nerve palsy by interference with the blood-supply to the nerve.

A state of shock may be present from birth or may develop gradually in an infant in whom adequate respiration cannot be established. The infant becomes limp and toneless, with relaxed sphincters, and shows a leaden-grey cyanosis or pallor. (This condition has been described as *asphyxia pallida*.) The pulse is feeble and rapid, or may be pathologically slow or irregular. The respiratory movements when present are irregular and shallow and may be of the Cheyne-Stokes type. The peripheral circulation is poor, and the skin may show mottling or marble veining. Examination may show evidence of intracranial hæmorrhage or intracranial damage due to prolonged anoxia. The condition may be made worse by undue handling and chilling during initial resuscitation.

The main principles of treatment should be the clearing of the respiratory tract, maintenance of a reasonable body temperature, the provision of a high oxygen concentration in the inspired air, and rest. These conditions are best achieved in the infant incubator. It may be necessary to use assisted respiration through an endotracheal tube if the respiratory movements are inadequate.

Recovery may gradually take place or death may occur from the inevitable progression of the underlying pathological process.

Persistence of cyanosis despite establishment of respiration. Cyanosis may be generalized or localized to the extremities. The infant should be stimulated to cry. Cyanosis which deepens with crying suggests a congenital cardiac lesion with a right to left shunt, or intracranial damage. Cyanosis which is lessened by crying and which returns with shallower respiration suggests a respiratory cause, such as atelectasis or secretion remaining in the respiratory passages.

Respiratory causes of cyanosis

Atelectasis. The fœtal lung has the consistence of a solid tissue. The first respiration expands the alveoli of a relatively small area, and although

expansion of the lung progresses rapidly with successive respiratory efforts total expansion may not be achieved for some hours. In the premature infant this process is even slower. The tissues around the lung root and the posterior part of the lower lobes are the last to expand. Atelectasis is defined as a partial or total continuation of the fœtal state, but the term is used only when symptoms are present. In atelectasis the breathing is shallow and rapid, with periods of apnœa and cyanosis which is variable in degree. Physical examination of the chest gives inconstant signs. The percussion note may not be impaired unless a large area of atelectasis exists. Auscultation of the newborn infant shows harsh breath sounds, often with accompanying large tube râles. The presence of fine râles indicates a pathological state and they may be heard over atelectatic lung. Weak or poor air entry is sometimes found, but may be obscured by the transmission of breath sounds from adjacent lung. Radiologically streaking is seen extending out from the hilum with diminished translucency of the lung field, and the appearances are not the same as those of the massive or lobar collapse seen in later childhood.

It is important to recognize and treat atelectasis at an early stage, as there may be absorption of air from the part of the lung which has expanded, with increasing cyanosis and anoxia leading to death. Incompletely expanded lung also provides an ideal tissue for infection and pneumonia.

The treatment consists of clearing the air passages and stimulating crying, to increase the depth of inspiration. An adequate oxygen concentration should be maintained in the inspired air by the intranasal administration of oxygen or by the use of an oxygen tent or incubator. In more severe cases in which the lung has never expanded sufficiently for full oxygenation, or when adequate ventilation has never been present from the time of birth, it may be necessary to use assisted respiration by endotracheal tube until expansion takes place. Antibiotics should be given for a few days if there has been delayed expansion of the lungs.

Respiratory distress syndrome (Hyaline membrane). The respiratory distress syndrome with pulmonary hyaline membrane and atelectasis is most frequently seen in premature babies, the babies of diabetic mothers, and infants born by Cæsarean section.

The ætiology of the condition is obscure and no single theory of its causation is adequate. It seems probable that there are multiple causative factors.

The condition often develops in infants who have required vigorous resuscitation after birth, and the initial sign is an increased respiratory rate and a grunting expiration. These may develop from 2 to 24 hours after birth. The respiratory rate increases to above 60 and intercostal and xiphisternal recession appear. Diaphragmatic respiration becomes marked, and see-saw breathing is seen in which the abdomen rises and the sternum

retracts during inspiration. Periods of apnœa occur, during which cyanosis develops and the infant froths at the lips. The infant tends to be limp. On clinical examination of the chest the air entry may appear to be reasonably good but generally is diminished, with inpiratory râles heard on, deep respiration. X-ray examination may show a characteristic appearance of a diffuse reticulo-granular type with a contrast between the air-filled bronchi and the surrounding non-aerated lung.

The syndrome develops rapidly and may cause death within a few hours or days, or may progress to a maximum at 3 to 4 days and then slowly improve. The prognosis is grave, and is worse in premature babies than in full term infants.

These infants should be nursed in an incubator with oxygen concentrations as high as are necessary to abolish cyanosis. The humidity should be over 80 per cent, and ærosols such as Alevaire, streptokinase or streptodornase may be nebulized into the incubator, although these drugs are not strikingly effective. The infant is given antibiotics, usually penicillin and streptomycin or tetracycline, to prevent secondary infection of the lung. Feeding must be given by indwelling gastric catheter or intravenously.

A severe electrolyte imbalance may develop with acidosis and hyperkalaemia. The latter may prove fatal from its cardiac effect. Many workers administer bicarbonate, glucose and insulin intravenously to correct the electrolyte upset, the dosage being calculated from the change in pH of the blood. Although this form of therapy does not affect the underlying disease, the prevention of gross metabolic disturbance gives the infant a greater chance of survival. Hyperbaric oxygen has also been claimed to be of benefit.

If the infant survives the first week of the illness there is every chance of total recovery.

Pneumothorax. The expansion of the lung may cause patchy vesicular emphysema, and rupture of a bulla produces a spontaneous pneumothorax with sudden onset of dyspnœa and cyanosis. Unless a valve pneumothorax is present the air is rapidly reabsorbed. If the cyanosis persists and deepens, due to positive intrapleural pressure from a valve pneumothorax, it will be necessary to insert a needle into the chest connected to an under-water drain bottle and to permit the air to escape until the leak is sealed off.

Aspiration. The aspiration of mucus, liquor or, less commonly, of feeds or vomit may cause cyanosis. Bubbling respiration and an inspiratory wheeze may indicate that the mishap has occurred. Aspiration and postural drainage to recover the inspired material is immediately necessary, and subsequently oxygen and antibiotic therapy should be used to prevent secondary infection and pneumonia.

Nasal obstruction. The newborn infant breathes through the nose by instinct, but has to learn mouth breathing. Nasal obstruction by secretion,

œdema or congenital atresia of the nares may cause cyanosis and asphyxial attacks which are only relieved by the insertion of an airway or by holding forward,the tongue with the mouth open. Relief of obstruction due to infection or œdema may be given by the use of nose drops of ¼ per cent ephedrine in saline before feeds.

Cardiovascular causes of cyanosis

The cyanosis of congenital malformations of the heart is usually generalized and may be of any degree. It is often exaggerated by crying. A murmur is often, but not invariably, presént. The depth and course of the cyanosis offer a rough guide to prognosis, but the murmurs may be confusing. Many newborn infants have a cardiac bruit in the early days of life, without cyanosis and subsequently the murmur disappears. Deep cyanosis without a murmur may be indicative of congenital heart lesions with a grave prognosis. An enlarged heart, a loud bruit and mild to moderate cyanosis may may seem at first to indicate a mild cardiac lesion, but the failure of the baby to thrive and deepening cyanosis suggest complicated lesions and a poor prognosis. Murmurs without cyanosis are often of less serious consequence, although septal defects, coarctation of the aorta, or a widely patent ductus may lead to cardiac failure in the early weeks of life. Murmurs may not be heard when the newborn infant is first examined and may appear later when the congenital heart lesion becomes obvious. Congenital malformations of the heart with generalized cyanosis are usually complicated lesions involving some combination of septal defects, transposition of the great vessels and pulmonary stenosis. Exact diagnosis is difficult during the neonatal period and a guarded prognosis should be given, based on the cyanosis, dyspnœa and the response of the infant to feeding and effort.

Other causes of cyanosis

Cyanosis may be due to intracranial injuries, chilling, abdominal distension and the delayed effect of analgesics and anæsthetics used for the mother. Chilling due to undue exposure at the time of the first bath is a not uncommon cause of blueness. The body temperature is found to be low and the colour rapidly improves when the infant is warmed.

INFANT FEEDING

ONCE the infant has overcome the initial hazards of extra-uterine life, the problem of feeding becomes important. The rate of growth of the infant during the first six months is greater than at any other stage in life. The normal baby doubles his birth weight by the age of 5 months, trebles it by the end of the first year and quadruples it by the age of 2 years. To achieve this progress, the intake of food must be relatively great and of a quality which allows easy digestion and absorption.

At birth, however, the gastro-intestinal tract is scarcely ready for the task, and it is sufficient during the first fortnight of life if the infant maintains his status. After this time the infant's need for food is great and must contain in liquid form a reasonably balanced mixture of protein, fat, carbohydrate, minerals and vitamins. This is achieved by using human or cow's milk for infant feeding.

Discussion of infant feeding is beset with difficulties largely created by the use of systems of infant feeding. No system will ever meet the needs of every infant, for each baby is an individual with his own characteristics, habits and idiosyncrasies from the moment of birth, and if the baby does not thrive on a system it is more likely that the error lies in the system than in the infant.

However, it is necessary that certain basic facts should be stated as to quantity and quality of food, and these rules can do no harm so long as they are adjusted to meet the requirements of each baby. These rules are applicable to the mature baby after the age of 10 days and must be radically modified for feeding during the first 10 days of life.

Daily fluid requirements. Water is necessary for the infant in amounts which are relatively greater than at any other period of life. The infant kidney is not as capable of concentrating urine as is the adult kidney, and the urinary output must amount to nearly half of the total fluid intake in order to remove the waste products of metabolism. The losses of fluid from the skin, lungs and in the fæces are proportionately greater than in adult life. The infant requires approximately $2\frac{1}{2}$ ounces of fluid for every pound of body-weight during a period of 24 hours. This relatively enormous intake can best be appreciated by considering that an 11 stone man would ingest over 19 pints of fluid a day if his fluid requirements were on the same scale.

Calorie requirement. The diet should provide 50 calories for every pound of body weight in each 24-hour period. This requires a calorie value of 30 calories in each ounce of the feed.

Infants below average birth weight of 7 pounds require a relatively greater fluid and calorie intake, and the figures of requirements may rise to 3-3½ ounces and 60–70 calories for each pound of body weight per 24 hours in babies weighing under 5 pounds at birth.

Protein, fat and carbohydrate. Figures can be given for the amount of these substances which may be needed daily, but these are in fact supplied in a diet of breast milk or some reasonable dilution of cow's milk.

Minerals and vitamins. The only mineral which may be inadequately provided by a milk diet is iron, an element which is always jealously conserved in nature. At birth the baby has only small reserves of iron in the liver. During the period of intensely rapid growth in early infancy, there is a corresponding increase in the total number of red blood cells in the body. The reserve stores of iron in the body are soon exhausted in forming hæmoglobin for the extra red blood-corpuscles which are produced, and, unless adequate supplies of iron are available in the diet, the infant develops the hypochromic anæmia of infancy. Neither cow's milk nor human milk contain sufficient iron for this purpose, and it is usually desirable to supplement the diet with additional iron after the second month of life, or earlier in the premature infant. Ferrous sulphate mixture for infants (B.P.C.) may be given in doses of 4 ml. (♏ 60), or elixir of ferrous gluconate 0·6 ml. (♏ 10) twice daily.

Vitamins. The vitamin content of breast milk is probably adequate for the needs of the baby, but cow's milk which has been heated does not contain enough. It is generally agreed that the optimal daily intake of vitamin C is 50 mg. of ascorbic acid. The recommended intake of vitamin D to prevent rickets is 800 i.u. daily from all sources, and any natural source of vitamin D yielding this figure will also provide an adequate intake of vitamin A. Milk usually provides a satisfactory vitamin B dosage.

Additional vitamin D and C should be given to babies who are artificially fed, and it is probably desirable to do the same for breast fed babies. Vitamins A and D may be given as National Vitaminized Oil. The oil may be given from the age of one month and the dosage is gradually increased from a few drops until the full dosage of one drachm daily is reached. Fish liver oil concentrates such as Adexolin 0·5 ml. (♏ 7), Radiostoleum 0·5 ml. (♏ 7), or halibut liver oil 0·5 ml. (♏ 7) may be given instead of cod liver oil.

Vitamin C is usually given as orange juice diluted with water, sweetened with a little sugar, and given as an extra drink. The juice of half an orange may be given, or one drachm of the concentrated orange juice issued by the Ministry of Food. If the infant cannot tolerate orange juice, which sometimes causes colic, it may be replaced by rose hip syrup, black currant puree or tomato juice, or ascorbic acid may be added to the feeds.

Breast or bottle feeding

It is desirable that the baby should be breast fed whenever this is practicable, and that cow's milk should be used only when the mother cannot or does not wish to feed her own baby, or when her health renders breast feeding inadvisable. The proportion of babies who are successfully breast fed varies with nationality, social and economic circumstances, and according to the personal opinions of those who deliver and care for the infants. The dried milk preparations are widely advertised, but there is little publicity for the advantages of breast feeding.

Many expectant mothers will ask whether breast feeding will give their infants additional benefits compared with bottle feeding, and for what reasons. The following points have been advanced for and against this belief:

1. Breast feeding is nature's way. Cow's milk differs from human milk in its composition, and each carries the amino-acids, fats and minerals most necessary to the species from which it is derived and the most suitable for the young of the same species.

2. Breast feeding is easier and cleaner, and in commercial terms is 'direct from producer to consumer without the intervention of the middle-man'. Breast milk is virtually sterile and is given to the baby directly and at body temperature, while the preparation of an artificial feed involves many processes from the milking of the cow to the final feed in its bottle, and each step offers an opportunity for contamination and infection, which less readily occurs in breast feeding.

3. Breast feeding is more convenient. While it is true that breast feeding takes less time than the preparation and giving of the bottle, the latter may be given by some person other than the mother. Mothers who are forced by economic necessity to work for part or all of the day may not be able to breast feed their babies.

4. Breast feeding is cheaper. This argument does not carry very much weight as dried milk is now available in Britain to all mothers at a low cost.

5. Breast feeding affords psychological fulfilment to the mother. Psychologists have laid great stress on the part which breast feeding plays in the psychological development of the infant and the fulfilment of maternal

instinct. Even if these arguments cannot be accepted in their entirety, there is a great volume of opinion based on personal experience among parous women to support this belief.

6. Breast feeding creates a healthier baby. The breast fed baby never suffers from scurvy and rarely from rickets. Breast fed babies suffer fewer and less severe infections than bottle fed babies, especially when respiratory and gastro-intestinal illnesses are considered. Breast milk is more easily and completely digested than is cow's milk and is of greater help in the treatment of a sick baby. Sore buttocks occur less frequently in the breast fed infant than in the bottle fed.   '

ANATOMY AND PHYSIOLOGY OF LACTATION

The human breast is a multilobular gland composed of approximately twenty segments arranged radially from the nipple, the secretory or glandular tissue being mainly peripheral. The branch-like duct system from each segment converges to form a single duct which opens on the nipple. Immediately before opening on the nipple, each duct has a dilatation called the lactiferous sinus. This sinus lies immediately beneath the areola of the nipple and is a thin walled portion of the duct which is capable of distension by milk to a calibre of $0 \cdot 5$ to $1 \cdot 0$ cm. The alveoli are surrounded by a myoepithelial contractile network which also invests the ducts. The active elements of the breasts are supported by a connective tissue stroma and a variable amount of fat. The whole breast is lavishly supplied with blood.

Changes in the breast with maturation. Before puberty there is little difference between the breasts in the two sexes, and they consist of a flattened nipple, a rudimentary duct system and little glandular tissue.

As puberty approaches, the female breast shows development of the feminine contour due to nipple prominence and deposition of fat. With successive menstrual cycles ovarian œstrogens promote a development of the duct system, but hyperplasia of the secreting tissue does not occur until the time of pregnancy under the influence of placental œstrogens and progesterone. During pregnancy there is a considerable increase in the duct system, but the enlargement which is seen in the breasts is mainly due to the hyperplasia of the glandular tissue from the 12th week onwards. This may be due to an effect of the œstrogens on the pituitary or to a sensitization of the breast by pituitary secretion, permitting a response to the effect of the placental œstrogens and progesterone present in the blood. From the end of the 24th week onwards the breast is capable of secreting milk and during the last trimester colostrum can be expressed from the breast, although active lactation is held dormant.

Physiology of lactation. The factors which govern lactation are not fully known and it is convenient to discuss the processes of secretion, or formation of milk, and excretion, or the yielding of milk, separately.

The **secretion** of milk is the transformation of amino-acids, minerals, glucose and lipoids present in the blood-plasma into the caseinogen, lact-albumin, milk fats and lactose found in the alveoli and ducts. This process takes place by the activity of the epithelium of the alveoli. Only a portion of the milk yielded at a feed is preformed and the major portion is actually secreted during the time of feeding. There is evidence to support the belief that prolactin is mainly responsible for the secretion of the alveoli. This pituitary secretion is influenced by the level of the blood-œstrogens. When blood-œstrogens are low, as in the non-pregnant woman, the pituitary does not secrete prolactin. In the puerperium the blood-œstrogens are at a level which stimulates prolactin production and lactation, but if the level is further raised prolactin production and lactation may be inhibited. It is possible that the pituitary may secrete other substances which promote lactation, but this is speculative.

Other hormones may play a part in the production of milk. Thyroid and adrenal hormones are probably involved, but the evidence is inconclusive.

During the later months of pregnancy the breast is ready to lactate, but milk is not secreted. After delivery of the infant, colostrum is secreted for 24 to 48 hours and then the breasts become congested and the milk is secreted. The suspension of lactation until after the birth of the child and the expulsion of the placenta is attributed to an inhibitory substance secreted by the placenta. With the expulsion of the placenta this substance is no longer produced and once it has all been excreted from the blood-stream milk is produced.

The excretion or yielding of milk. The term sucking is often used to describe the process by which the baby gains milk. Sucking is in fact a relatively unimportant part of the complex process, and the term wrongly suggests that it is wholly dependent on an activity of the baby.

When lactation is well established, observation of a baby at the breast shows that the process is a complicated one. The infant draws the nipple into the mouth and champs on the areola with the gums. The lips form a seal on the nipple and areola and there is suction in the mouth and swallowing of the milk obtained. If the sucking infant is removed from the breast, milk continues to run or spurt from the breast, indicating an active excretion by the breast as well as active sucking by the infant.

Part played by the infant. When the baby takes the breast the nipple is drawn into the arch of the hard palate and held there by the tongue to be

exposed to suction, which clears the milk to the back of the mouth to be swallowed. The lips form a seal on the breast and the gums champ on the areola. This champing action falls on the dilated lactiferous sinuses of the duct and cause a milking effect which propels the contents into the infant's mouth.

Active excretion by the breast. The active excretion which can be demonstrated is probably due to the contractile myo-epithelial network which invests the alveoli and ducts, and implies an active process in the breast. Veterinary studies have shown that stimulation of nerve endings in the nipple initiates impulses which are conveyed to the posterior lobe of the pituitary gland by a reflex arc, and provoke a release of pitocin to the bloodstream. The pitocin acts on the myo-epithelial structures of the duct system and causes propulsion of the milk along the ducts. This has been termed the let-down reflex. The reflex arc can be interrupted or inhibited psychologically with a failure of excretion of milk. These observed facts have been confirmed in the human, and the let-down reflex is known to parous women as 'the draught' or a prickly sensation in the breast after the baby has begun to feed, coinciding with the onset of the flow of the milk.

Relation between physiological observation and clinical applications. In satisfactory breast feeding it is evident that the glandular tissue of the breast must be adequately developed and a hormonal secretion sufficient to stimulate the breast to lactate must also be present.

The infant must be able to take the nipple into the mouth and exert suction, and to oppose the gums in order to milk the lactiferous sinus. Even when these two requirements are satisfied, satisfactory lactation is dependent upon the establishment of the let-down reflex and this may be inhibited by a psychological upset in the mother or by painful stimuli provoked by the baby.

Failure of lactation can be explained on these grounds in almost every case.

Composition of colostrum and breast milk. For the first 2 days colostrum is secreted by the breasts and on the 3rd and 4th days the secretion changes to normal breast milk. Colostrum is a yellow fluid containing large fat globules, the colostrum corpuscles, and has a high mineral, low sugar and moderate protein content. It has been claimed that colostrum is important to the infant because of a high content of antibodies but, while this is true of other mammalian species, it is probably not important in the human. Colostrum is said to possess laxative qualities and aids the evacuation of meconium. No laxative constituent has ever been demonstrated.

When the secretion changes from colostrum to milk, the colour changes from yellow to a bluish-white. With successful lactation the amount of

milk which is given increases daily, and by the 5th day should reach a total of 10 ounces, and by the 10th day over 16 ounces should be obtained.

COMPOSITION OF BREAST MILK

	Protein per cent	Fat per cent	Carbohydrate per cent
Colostrum . . .	2·25	3·15	4·00
Milk	1·25	3·50	7·25

Breast milk protein contains three fractions: caseinogen, lactalbumin and lactglobulin. The latter is present only in small amounts and the proportion of lactalbumin to caseinogen is 2 to 1. The calorie value of breast milk is 20 calories per ounce.

Management of feeding in the newborn. The essence of the introduction of breast feeding in the newborn infant is a gradual increase in the time at the breast and the amount which the infant is allowed to take or can obtain. The objects of this gradual approach are to stimulate lactation; to encourage the baby to suck without allowing him to become discouraged by failure to obtain milk; and to accustom the nipples to the mild trauma of sucking.

The following points should be considered:

Interval after birth when feeding is first allowed. Although the baby should be handled by the mother as soon after birth as possible, it is probably best to allow the first feeding 6 to 8 hours after delivery. Both mother and baby deserve this period of rest and recovery. If the infant is ill, or has suffered from a difficult delivery, the baby may be kept from the breast and resting until 24 to 48 hours have elapsed.

Frequency of feeding. With babies of average birth weight it is usually convenient to permit three feedings on the 1st day and thereafter five feeds at intervals of 4 hours.

Small babies with a birth weight of 6 pounds or less are usually better with more frequent feeds. A 3-hour interval between feeds and a total of six or seven feeds in the 24 hours proves more satisfactory. Some babies of normal weight who tire easily at feeds or who are especially hungry because of delayed lactation, may do better on a 3-hourly schedule. Large babies of 9 pounds and over are often difficult to satisfy in the early days of lactation and are more contented when fed six or seven times in the 24 hours.

The regimen must be varied to suit the individual baby and an elasticity of technique must be maintained. In general, a 4-hourly schedule will be satisfactory for the great majority of newborn infants.

Time at the breast. From the 1st to the 7th day of feeding it is wise to increase the time permitted at the breast with each successive day. On the 1st day 1 or 2 minutes at each breast is usually sufficient and this is gradually increased to 10 minutes by the 7th day.

Alternation of breasts. Each feed should be started on the breast which was taken last at the previous feed. During a feed from one breast lasting 10 minutes the infant will obtain two-thirds of the milk in the first 5 minutes. During the second 5 minutes the yield is much less, but is of a higher fat content as the breast is emptied. When put to the second breast, only part of the milk may be taken and the breast left with a residue of rich milk. At the next feed this breast should be offered first to ensure that this milk is taken and the breast emptied, as this promotes good lactation. If the breast is continually left with a residue of milk, lactation may be diminished and may eventually fail.

One breast or two breasts at a feed. In the young infant it is usually necessary to offer both breasts at each feed time to supply the amount of milk required. Once lactation is thoroughly established, some women can supply the baby's needs from one breast only at each feed.

Amount taken from the breast. Experience has shown that the baby will feed at each breast for 7 to 10 minutes once lactation has become well established. This is an arbitrary time and in fact the baby will feed until his needs are satisfied or until the breasts are emptied. This may be achieved by the end of 7 to 10 minutes at each breast in the average case, but the time required may be as little as 4 minutes, or it may take as long as 15 minutes at each breast. The infant is usually the best judge on this point, and confirmation may be found in an adequate gain in weight.

Extra fluids. Under civilized conditions the baby is warmly wrapped up and is kept in a warm environment. The infant may not obtain from the breast an adequate fluid intake during the first few days and will show mild dehydration and irritability. The infant should be offered fluid by spoon during these days. Boiled water or fifth normal saline are the ideal fluids, and are offered after each feed in sufficient amount to satisfy thirst.

Position during breast feeding. The infant is usually nursed by the mother propped up in bed or sitting in a low-armed chair. The infant is held in the crook of the arm on the same side as the breast which is to be given, with the weight of the baby supported on the forearm. The head should be allowed to extend beyond the bend of the elbow as most infants feed better with the neck extended rather than flexed. Whether the infant

lies flat or is kept upright is usually best determined by trial as this varies from one baby to the next.

With the baby in this position the mother should bend forward slightly and allow the nipple to fall to the baby's mouth. When the breast is large or fat the redundant tissue can be restrained with the fingers of the other hand and the nipple allowed to protrude between the extended fingers.

If the mother is ill, the infant may be laid on the bed alongside her between the trunk and the arm. By turning on her side the mother can bring the nipple to the baby's mouth.

Reluctance to feed. This will often indicate that the infant is ill. A healthy baby will sometimes refuse to take one breast, but will feed if the other breast is offered first. In other cases the infant refuses to 'get on' the breast, but may be encouraged if a few drops of milk are expressed and allowed to fall on the baby's lips.

Deficient lactation. Adequate lactation has been defined as a secretion of 10 ounces by the 5th day and 16 ounces by the 10th day. If these amounts are not achieved, the baby of normal birth weight will not be adequately fed.

Failure of lactation. This may be due to an inadequate development of gland tissue, although this bears no relation to the size of the breasts. Some women with small breasts with little fat, produce large quantities of milk, while the large fat breast may contain little secreting tissue. There is no therapy which will promote lactation under these conditions.

Delayed lactation. A proportion of women are slow to lactate, but if the food, and especially fluid, intake is adequate, lactation is eventually established. Prolactin by injection has been disappointing, while milky drinks such as Lactagol are probably only effective by their psychological effect.

The best stimulus to delayed lactation is emptying the breasts and this is achieved more effectively by the infant than by manual expression.

Self demand feeding. In self demand feeding it is the practice to feed the infant whenever he cries and the cry cannot be attributed to colic, wind or other cause of physical discomfort. The demands for feeds may be as frequent as 12 or 14 times in the day at the start, but as the infant grows older are reduced in number until the rhythm approximates closely to a 3 or 4 hour schedule. It is argued that this system makes for a happy and contented baby and avoids possible psychological upsets which may give rise to symptoms in later infancy and childhood. This technique

requires that the baby be kept in a cot by the side of the mother's bed so that he may be lifted and fed at the times when he demands this attention. This is easy to achieve in a private house and in some institutions, but may not be possible in maternity wards of large size because of the distraction to the other mothers.

DIFFICULTIES IN BREAST FEEDING

These difficulties may arise from causes in the infant or from causes in the breasts.

Causes in the infant. If the baby is suffering from an infection, cerebral trauma or some congenital heart lesion, he may be too weak to take the breast or may tire before a sufficient amount of milk is taken. In such cases it is necessary to feed the infant with a spoon or by tube until the breast can be taken satisfactorily.

When the baby is very small there may be disproportion between the size of the nipple and the baby's mouth, but this will be remedied as the baby grows. Congenital defects such as hare lip and cleft palate will create mechanical difficulties in feeding and similar difficulties will arise when there is obstruction to nose breathing. This is occasionally caused by the occlusion of the anterior nares by the infant's upper lip when the nipple is taken into his mouth.

Over-distension of the stomach with air will cause the infant discomfort and he may refuse to take the breast. This excessive swallowing of air may arise from difficulty in taking the nipple and it may be necessary to de-wind the baby several times during the feed.

Air swallowing. During a feed the infant must alternate in some rhythm between swallowing and breathing. The ability of different babies to achieve this varies very greatly, and the inhalation of milk during respiration causes choking and the expulsion of milk from the air passages by coughing. Most babies, however, swallow air with the milk.

If a considerable volume of air is swallowed this may inconvenience the baby in one of several ways. The air may pass from the stomach to the intestines and cause colic between the feed times. If the swallowed air remains in the stomach and the pylorus remains closed, the stomach becomes distended to capacity before an adequate amount of milk is taken and the infant refuses to feed any longer. When the infant is replaced in his cot the air may be expelled from the stomach and carry milk with it as vomit.

Although it must be admitted that some infants do not appear to suffer discomfort from considerable gastric and intestinal distension with air, the majority are inconvenienced by this. It is, therefore, desirable to bring up the wind one or more times during a feed. To do this without spilling out

the milk as well requires a certain degree of practice and dexterity on the part of both the mother and the infant. The infant is sat upright to bring the air bubble up to the fundus of the stomach. The mother places one hand across the upper abdomen and lower ribs of the infant with the baby leaning forward against this hand. With her free hand the mother rubs or pats the back of the baby quite firmly. After an interval the baby will bring up wind with a loud noise. This may have to be repeated several times before the stomach is empty of wind. Alternatively, the baby may be held face downwards against mother's shoulder, and the back rubbed and patted. Some babies bring up the wind most satisfactorily when lying face downwards across the mother's knee. The wind should be brought up at least once during the feed and always at the finish of the feed.

Causes in the mother. *Anatomical.* When the nipples are poorly developed or retracted, the infant cannot draw the nipple into the correct position in the mouth for satisfactory feeding. This should be detected during antenatal examination and corrected by the wearing of nipple shields. In cases in which treatment has not been given before delivery, the condition may improve rapidly under the stimulus of the infant's attempts to feed or may be overcome by feeding through nipple shields, although this is seldom found to be successful. Inadequate development of the nipple may prove an insuperable barrier to satisfactory feeding in some cases.

Congestion. On the 3rd or 4th day of the puerperium, the effect of the placental inhibitory substance diminishes and the breasts come under the influence of prolactin with a great increase in vascularity and secretion of milk. The breasts become congested and are hard, knotty and painful. The congestion may be so severe that milk cannot be taken and the breasts are so acutely painful that the mother is not able to tolerate the infant at the breast. This state of congestion develops very rapidly and a close watch must be maintained. Before congestion is fully established, the acute stage may be prevented by manual expression of milk or by the use of a breast pump. Manual expression of the congested breast may be so painful that the woman is unable to tolerate the discomfort, and, even if the pain can be borne, the skin of the breast may be bruised by unskilled expression. Some midwives become very expert at expression of the breasts by hand and are able to teach the mother to do this for themselves. In some centres the pregnant woman is taught to express the breasts daily during the last few weeks of pregnancy and it is claimed that this reduces the frequency and severity of congestion of the breast during the first few days of the puerperium.

If manual expression is not possible the use of a breast pump may help to relieve the congestion. The old fashioned rubber and glass suction pump is seldom effective and may cause great discomfort to the woman or

traumatize the nipple. The electric breast pump, with the rhythmic gentle negative pressure created in the soft rubber breast cup, is often more'successful. When œdema of the nipple is present, it is usually advisable to avoid the use of breast pumps.

In other cases the administration of stilbœstrol damps down the secretion of milk and prevents the full development of congestion. Oral administration of 5 mg. of stilbœstrol may be repeated at 4-hourly intervals for 3 doses. The breasts should be well supported with wool and bandage.

Cracked nipple. The skin of the nipple may become traumatized and fissured in the early days of feeding. This is more common in the fair-skinned mother. The crack or fissure may only be visible with the aid of a lens, but causes severe pain when the infant feeds. The infant should not be allowed to feed on the breast for 24 hours or more and the breast emptied by expression. When feeding is started again, the time for each feed should at first be short and increased gradually if the crack remains healed. Many local applications are used but none is specific. Any such application should not stick so that newformed epithelium is not torn off when the dressing is removed; it should be antiseptic but not cause chemical or allergic reaction; it should be harmless to the baby so that it need not be wiped away before a feed. Flavine in liquid paraffin would have these qualities.

Breast abscess. Infection of the breast and abscess formation sometimes follow gross engorgement or cracked nipples, but may appear without obvious cause. The infection is usually staphylococcal, and may progress to abscess formation. The breast becomes tender, hot and swollen and the mother has pyrexia and toxic signs.

The baby cannot be fed from the affected breast during the acute stage because of the pain caused to the mother, but the breast must be kept emptied as damming back of milk tends to promote spread of infection. Early recognition of infection may permit cure by antibiotic therapy, or incision and drainage of the abscess may be necessary. (See p. 590.)

Once the acute stage is over, there is no necessity to keep the baby off the breast or to wean the baby unless the abscess involves the nipple or nearby tissues.

Contra-indications to breast feeding. The principal contra-indications are severe heart or kidney disease in the mother, or puerperal mania. Pulmonary tuberculosis which has recently been active is usually a complete bar to breast feeding by reason of the added strain to the mother and the risk of reactivating the disease. The risk to the infant is not inconsiderable if the mother has active pulmonary tuberculosis, and this risk is present in the same degree whether the mother feeds the baby at the breast or gives him feeds by bottle.

Preparation for lactation. The best preparation for lactation is to ensure that the expectant mother is aware of the normal course of events following delivery and is mentally prepared for breast feeding.

Attention must be given during antenatal examination to the state of the nipples. A poorly developed, retracted or inverted nipple cannot be drawn into the infant's mouth and may suffer trauma because the baby cannot get on to the nipple properly. The nipples should be examined to see whether they are retracted or inverted, and to ascertain whether the nipple can be protracted. The external appearance of the nipple is not a certain guide and the base of the nipple should be gently pinched to make it protrude. When the nipples are retracted the mother should be encouraged to wear glass nipple shields during the day, and at night during the later part of pregnancy, as this will, in the majority of cases, correct the abnormality.

There should be no attempt to harden the nipples with spirit; only the ordinary hygienic measures are necessary. Dry skin on the nipples may be treated with an occasional application of lanoline. Expression of the breasts during the last few weeks of pregnancy has been advocated as a way in which congestion may be prevented, but this requires special instruction to the mothers, not all of whom find the technique easy to learn.

No special dietetic regime need be advised so long as the expectant mother is taking a normal balanced diet with an adequate protein, calcium, iron and vitamin intake.

Excretion of drugs in breast milk. Many drugs which are taken by the mother are excreted in the breast milk and in some cases the concentration may be sufficient to affect the infant. This may occur when heavy doses of the barbiturates are given to the lactating woman and the infant may be affected by the amounts secreted in the milk. The possibility must always be kept in mind. Purgatives taken by the mother may affect the infant, and an excess of citrous fruits or large stoned fruits may have a similar effect. Nicotine may be secreted in the milk but does not appear to affect the baby; smoking, however, seems to reduce the milk output and nursing mothers should smoke only in moderation.

ARTIFICIAL FEEDING

When breast milk is not available, the infant is usually fed on cow's milk. In rare cases of intolerance to cow's milk other mammalian milks may be used; ass's, mare's or goat's milk have been employed. When an infant shows an allergy to cow's milk protein, various dried milks may be given from which the protein has been in part removed, or a vegetable milk made from soya bean can be used. Milk allergy is uncommon and causes colic and frequent, loose, undigested stools. In general, liquid, dried or evaporated cow's milk,

modified by dilution with water and the addition of sugar, is the basis of artificial feeding. Further modifications by peptonization or by the addition of citrater are occasionally used in cases of digestive upset.

It is claimed that humanized cow's milk mixtures should be used for infant feeding, but it is not possible to change cow's milk into human milk and the term should not be used. So long as it is realized that the cow's milk cannot be humanized, but can very readily be adapted to the needs of the human infant, then artificial feeding need present few difficulties.

COMPARISON OF THE COMPOSITION OF HUMAN AND COW'S MILK

	Protein per cent	Proportion of caseinogen to lactalbumin	Fat per cent	Carbohydrate per cent
Human milk	1·25	1 to 2	3·5	7·25
Cow's milk	3·5	4 to 1	3·5	4·75

Caloric value of 1 ounce of milk = 20 calories.

In both milks the carbohydrate is lactose and the difference lies only in the quantity present. The percentage of fat is approximately the same in both milks, but the emulsion of fat in cow's milk is much coarser. Human milk has a bluish, watery appearance and fat does not readily separate to the surface. In cow's milk the coarser emulsion of fat gives a yellow appearance and the fat globules separate as cream, and this coarse fat emulsion presents one of the problems in using cow's milk to feed the young infant because of difficulty in digestion.

The total protein in cow's milk is twice as great as in breast milk and, although the lactalbumin content is the same, cow's milk contains eight times the caseinogen of breast milk. Lactalbumin is a soluble, heat coagulable protein and is easily digested. The skin which forms on boiled milk is lactalbumin. Caseinogen is converted to casein by the action of gastric juice and cow's milk curds are coarser than those produced in breast milk. The junket produced by the action of rennet on milk is casein. This high protein content presents the second digestive difficulty in the use of cow's milk in infant feeding.

These difficulties are reduced by diluting cow's milk with water for feeding young infants, but this also reduces the calorie value and concentration of sugar. The addition of extra sugar compensates for both these deficiencies.

General principles for artificial feeding. After the 7th day of life, the infant requires 2½ ounces of fluid for each pound of body weight per diem. Each fluid ounce of feed should have a value of approximately 20

calories. During the first week of life these figures are reduced, and the size and strength of feeds are gradually increased as the digestive capacity of the infant is established.

Feeding with liquid cow's milk

Cow's milk is a potentially dangerous liquid and may suffer bacterial contamination from the cow, the milker, or from the handling of the milk before it reaches the consumer. The inspection and tuberculin testing of herds, the use of mechanical milking techniques and the pasteurization and hygienic bottling of milk have greatly reduced the hazard of infection with tubercle bacilli, streptococci, *E. coli*, diphtheria bacilli, *B. typhosus*, etc., but milk should always be brought to the boil before being used in infant feeding, no matter what grade of milk is employed.

Strength of feeds. Opinions differ widely on the dilution of milk which should be used for infant feeding.

Constant dilution. One school of opinion states that the same dilution of milk should be used, whatever the age or weight of the baby. Thus, $1\frac{3}{4}$ ounces of cow's milk plus $\frac{3}{4}$ ounce of water is given in each period of 24 hours of each pound of body-weight plus 1 teaspoonful of sugar per pound up to a maximum of 10 teaspoons in the day.

EXAMPLE.—A 10 pound baby is given:

Cow's milk	.	.	.	.	.	$10 \times 1\frac{3}{4}$ oz. = $17\frac{1}{2}$ oz.
Water	.	.	.	.	.	$10 \times \frac{3}{4}$ oz. = $7\frac{1}{2}$ oz.
Sugar	.	.	.	.	.	10×1 tsp. = 10 tsp.

This quantity of feed is divided into five equal portions and the feed given every 4 hours.

Varying dilution. It is more usual to give the young infant a dilute feed and to increase the concentration of cow's milk as the age and weight of the baby increases. This method gives the immature digestion a weak mixture to deal with and the strength of cow's milk in the mixture is increased as the digestive powers increase.

The usual dilutions which are employed are related to the age of the infant.

2 to 4 weeks	1 part cow's milk	plus sugar
1 to 3 months	2 parts cow's milk	1 part water plus sugar
3 to 6 months	3 parts cow's milk	1 part water plus sugar
Over 6 months	Whole cow's milk	1 part water plus sugar

<div align="center">

9 pound baby—5 weeks of age

Total per day, $9 \times 2\frac{1}{2}$ oz. $= 22\frac{1}{2}$ oz.

Two to one mixture

</div>

Cow's milk	15 oz.
Water	7½ oz.
Sugar	9 tsp.

<div align="center">

12 pound baby—3½ months of age

Total per day, $12 \times 2\frac{1}{2} = 30$ oz.

Three to one mixture

</div>

Cow's milk	22½ oz.
Water	7½ oz.
Sugar	10 tsp.

Simplified system. Experience has shown that a rule of thumb method may be evolved from the above principles. Briefly, and without detailing the reasons, the calculation of the correct feed may be made in the following way for infants on a 4-hourly schedule.

Divide the weight of the baby in pounds by two and this gives the size of each feed in ounces: 1½ ounces of the feed should be of water and the remainder of cow's milk with the addition of 1 to 1½ teaspoonfuls of sugar.

EXAMPLES:

Weight of baby .	7 lb.	9 lb.	12 lb.	15 lb.
Size of feed . .	3½ oz.	4½ oz.	6 oz.	7½ oz.
Feed made of				
Water . . .	1½ oz.	1½ oz.	1½ oz.	1½ oz.
Cow's milk .	2 oz.	3 oz.	4½ oz.	6 oz.
Added sugar .	1-1½ tsp.	1-1½ tsp.	1-1½ tsp.	1-1½ tsp.

The use of dried milks

A great variety of different dried milks are available commercially for infant feeding, but the majority of these milks fall into one of three categories: full cream dried milk, half-cream dried milk and humanized dried milk. In many cases the addition of extra vitamins or iron, or the modification of the protein in the milk is claimed to afford the product special advantages for the feeding of infants, but the milk remains of the same fundamental type. .

Full cream dried milks. These represent the powder which results from the evaporation of cow's milk to dryness. When one level scoop or measure of the powder is reconstituted to 1 ounce with water the resulting fluid is equivalent to 1 ounce of cow's milk. The scoop of the dried powder has a calorie value of 20 calories.

The process of drying has an effect on the protein of the milk and causes some degree of breakdown of the proteins to simple compounds. The heating also destroys the vitamins to some extent; vitamin C is most affected with vitamins A and D being reduced to a lesser degree.

Half-cream dried milk powders. These dried powders are prepared by the partial skimming of liquid milk before drying and sugar is then added to raise the calorie value of the powder. Half-cream National Dried Milk differs from the usual commercial half-cream milk in that there is no added sugar in the dried powder, and affords the extra advantage that sugar can be added to the reconstituted feed to suit the needs of the individual baby. The calorie value of one scoop of the half-cream dried milks is usually 16 to 18 calories.

Humanized dried milk powders. Humanized dried milks are usually prepared by the removal of some protein and the addition of a considerable amount of sugar. The caloric value is usually 18–20 calories per scoop.

Use of dried milks. The humanized and half-cream dried milks should only be used in the early weeks of life and should not be employed after the infant has reached 10 pounds in weight or 3 months of age.

These milks are usually given as one scoop for each ounce of feed which is required, and, except for half-cream National Dried Milk, require no added sugar.

Full-cream dried milk. The number of ounces of feed which should be given every 4 hours is determined by dividing by two the weight of the infant in pounds. If $1\frac{1}{2}$ is subtracted from this figure, the number of scoops of dried milk required at each feed is found. This quantity of dried milk powder is reconstituted with water to make the full amount of feed required and sugar added as $\frac{1}{2}$ to 2 teaspoonfuls per feed according to the need of the infant.

EXAMPLES:

Weight of baby	10 lb.	12 lb.	15 lb.
Size of feeds 4-hourly . .	5 oz.—$1\frac{1}{2}$	6 oz.—$1\frac{1}{2}$	$7\frac{1}{2}$ oz.—$1\frac{1}{2}$
No. of scoops of F.C. Milk .	$3\frac{1}{2}$ scoops	5 scoops	6 scoops
No. of ounces of water . .	5 oz.	6 oz.	$7\frac{1}{2}$ oz.
Added sugar	$\frac{1}{2}$-2 tsp.	$\frac{1}{2}$-2 tsp.	$\frac{1}{2}$-2 tsp.

Evaporated or condensed milks. These milks are becoming increasingly popular for infant feeding in this country. Full cream evaporated milk and half cream milk are both available. Sweetened condensed milks are not suitable for routine infant feeding. Full cream evaporated milk is cow's milk which has been concentrated to two-fifths of the original

volume, and dilution of 1 ounce of the milk with $1\frac{1}{2}$ ounces of water re-constitutes ordinary liquid cow's milk. The calorie value of full cream evaporated milk is 50 calories per ounce and that of half cream evaporated milk is 34 calories per ounce. Further dilution of the milk is necessary for infant feeding.

Addition of sugar to the feed. Lactose, or milk sugar, exists in nature only in mammalian milk and is therefore expensive to use for sweetening artificial feeds. Glucose is also relatively expensive and may sometimes cause fermentation in the gut with loose stools and sore buttocks. Sucrose (cane sugar or table sugar) is a disaccharide which is split on digestion to glucose and fructose and is well-suited for sweetening artificial feeds. The amount which is necessary at each feed varies from $\frac{1}{2}$ to 2 teaspoonfuls and should be varied according to the calories required and the bowel habit of the infant. Too little sugar may cause a costive bowel habit and an excess may cause relaxed stools. The correct amount is usually determined by trial.

When an otherwise apparently correct feed with adequate sugar still leaves the infant constipated, use of brown or demerara sugar may be helpful. With relaxed stools dextri-maltose may be given. The calorie value of a level teaspoonful of sugar is about 15–20 calories.

ARTIFICIAL FEEDING DURING THE FIRST TEN DAYS OF LIFE

The baby may be fed with liquid milk or any variety of dried or evaporated milk so long as the mixture is given in sufficiently dilute form. It is usual, however, to give half-cream dried or evaporated milk or humanized dried milk. The first feeds must be small and dilute and the increases in size and strength made very gradually until full feeds are given by the 8th day.

Although there are many methods which may be employed, it is proposed to discuss only the simplest method. The figures given are based upon an average baby of 7 pounds birth-weight fed at intervals of 4 hours. With smaller or larger babies the amount must be adjusted accordingly.

Quantities. The baby is offered $\frac{1}{2}$ ounce of boiled water every 3 or 4 hours during the first 24 hours of life. On the 2nd day $\frac{1}{2}$ ounce of the milk mixture as detailed later is given 4-hourly and the amount increased by at least $\frac{1}{2}$ ounce each day until the baby is offered $3\frac{1}{2}$ to 4 ounces at each feed on the 8th day of life. These quantities must be adjusted in a common sense way; in some instances the baby may refuse to take all the feed and should not be pressed; in other cases the baby may appear to be hungry and should be offered more.

Strength of feeds. By the time the baby is 8 days old the feed can be calculated according to the weight of the infant. This may be briefly summarized as follows:

1. Liquid milk: $1\frac{1}{2}$ ounces of cow's milk, water $1\frac{1}{2}$ ounces, sugar $1\frac{1}{2}$ teaspoonfuls.

2. Dried milk.
   Full cream: $1\frac{1}{2}$ scoops, water 3 ounces, sugar $1\frac{1}{2}$ teaspoonfuls.
   Half-cream National Dried Milk: 4 measures, water 4 ounces, sugar $1\frac{1}{2}$ teaspoonfuls.
   Half-cream: 1 measure to 1 ounce.
   Humanized: 1 measure to 1 ounce.

3. Evaporated milk: 1 ounce milk, water 3 ounces, sugar $1\frac{1}{2}$ teaspoonfuls.

4. Half-cream evaporated milk: 1 ounce milk, water 1 ounce, sugar $\frac{1}{2}$ teaspoonful.

When artificial feeding is introduced on the 2nd day of life, any of these standard mixtures may be given in $\frac{1}{4}$ strength, i.e. 1 part of the mixture diluted with 3 parts of water. On the 3rd or 4th day the mixture is given in $\frac{1}{2}$ strength, i.e. 1 part of the mixture to 1 part of water. By the 5th or 6th day $\frac{3}{4}$ strength may be used, i.e. 3 parts of the standard mixture to 1 part of water. On the 8th day and subsequent days the mixture may be given in full strength and increased as the baby's weight rises.

These feeds must always be varied in accordance with the individual baby's needs and idiosyncrasies. Smaller babies should have the strength of the feeds increased more slowly and full strength feeds are not given until the 9th or 10th day. If the stools become relaxed the strength of the feed should not be increased for a day or two until they have improved.

These figures may be summarized in the following table.

Day	1	2	3	4	5	6	7	8	9
Amount of feed in ounces	$\frac{1}{2}$	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	$3\frac{1}{2}$
Strength of feed	water	$\frac{1}{4}$S.	$\frac{1}{4}$S.	$\frac{1}{2}$S.	$\frac{1}{2}$S.	$\frac{3}{4}$S.	$\frac{3}{4}$S.	F.S.	F.S.

Complementary and supplementary feeds. A complementary feed is one which is given to augment a feed from the breast; a supplementary feed is one which replaces a breast feed. Complementary feeding is sometimes necessary when lactation is only slowly established. Complementary feeds are unnecessary before the 5th day as the baby may be given water to quench thirst. If the weight is still falling, or is stationary on the 5th day, or if the baby seems very hungry, test weighing may be carried out to determine exactly how much milk the baby obtains from the breast. The

baby is weighed fully clothed before the feed and again after the feed is over. The difference in weight is the amount of milk taken from the breast. The second weighing must be made before soiled napkins are changed, or the result is valueless.

If the milk yield is insufficient, the baby may be offered a complement after each feed to make up the deficit. The strength of the complement should be in accordance with the age of the infant (see table) and the amount which is required may be determined by test weighing at each feed. It is probably better to offer a standard amount after each feed and let the baby take as much or as little as he wants.

DISEASES OF THE NEWBORN

BIRTH TRAUMA

BIRTH injuries range from simple cutaneous trauma to severe internal hæmorrhages and may occur in normal deliveries, but are, however, more frequent in instrumental deliveries or when labour is complicated.

The prevention of birth injuries involves a consideration of the art of obstetrics and the striking of a balance between the safety of the mother and the child, when labour is difficult or complicated.
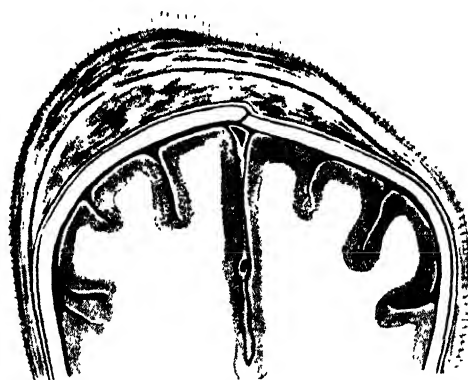
FIG. 228.   Caput succedaneum.
The swelling is formed by œdema of the structures lying superficial to the pericranium. Note that it is not limited to one bone. Compare with Fig. 229.

Birth injuries to the head

Caput succedaneum. This swelling is an œdema within the subcutaneous layers of the scalp often with skin ecchymoses or a deep hæmatoma. It is caused by the pressure on the head of the expanding cervix. A large caput succedaneum, referred to as the 'chignon' is produced by the use of the vacuum extractor. The swelling is maximal at birth, and lies across skull suture lines and rapidly disappears within a few days.

Cephalhæmatoma (see Fig. 229). Cephalhæmatoma is a subperiosteal hæmatoma which most commonly lies over one of the parietal bones. The hæmatoma is sometimes bilateral, but rarely affects the frontal or the occipital bones. A cephalhæmatoma never extends beyond the limits of a single bone and is fluctuant but incompressible. It never varies in tension

with crying and in these respects differs from the less common encephalo-cœle, which is a protrusion of the brain and meninges through a cranial defect. ,

The lesion is due to rupture of small vessels under the periosteum with bleeding. The blood-clot absorbs serum and the swelling increases in size for several days. Spontaneous absorption is the rule, but this may take s everal weeks. Ossification may take place around the periphery and create
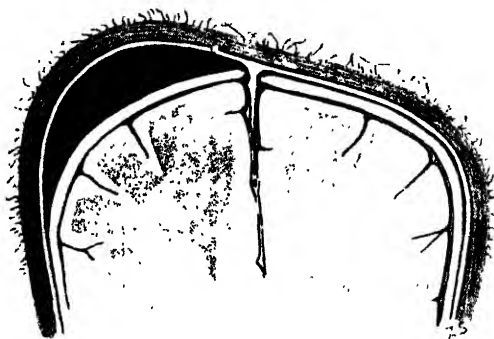
FIG. 229.   Cephalhæmatoma.

The swelling is seen to consist of blood lying between the pericranium and the skull and limited to the bone on which it started by the attachment of the pericranium to the suture.

a crater-like depression with a raised rim which may be palpated, and a mistaken diagnosis of depressed fracture may be made. A proportion of these patients have an underlying fracture of the skull which is the cause of the cephalhæmatoma.

The hæmatoma may be apparent at birth, but usually appears on the 2nd or 3rd day of life. No treatment is necessary and any unnecessary handling should be avoided. Aspiration invites the risk of infection. The condition may cause an asymmetry of the skull which persists for many months.

Skull fractures. These may be depressed, linear or stellate. Depressed fractures are usually groove or spoon shaped and occur unilaterally over the parietal bone, resulting from pressure from the sacral promontory or the forceps. The lesion may be detected on routine examination or symptoms may arise from pressure on the brain or underlying hæmorrhage. Neuro-surgical treatment is usually desirable, with elevation of the depressed segment, and evacuation and control of bleeding in cases in which symptoms arise, but in many cases the depression spontaneously resolves without treatment.

Linear and stellate fractures occur in difficult deliveries and may be

asymptomatic or associated with intracranial bleeding or pressure. Treatment is indicated when symptoms are caused by pressure or hæmorrhage.

Craniotabes. Although not due to injury, this condition is mentioned here for convenience. The skull may show areas of softening near the suture lines, especially in the parietal area, and the bone in these areas can be indented with a resilience like a ping-pong ball. The condition must be differentiated from osteogenesis imperfecta, rickets and lacunar skull. The latter shows characteristic X-ray honeycomb appearances. Craniotabes is not of significance and the bones develop and thicken normally, as the infant grows.

Intracranial injuries

Intracranial hæmorrhage has been held responsible for 40 to 60 per cent of stillbirths and neonatal deaths. The possibility of intracranial hæmorrhage should be kept in mind in all difficult, instrumental or breech deliveries, but especially in premature births and in prolonged or precipitate deliveries. Intracranial hæmorrhage may also occur in Cæsarean section or normal delivery.

The cerebro-spinal fluid acts as a cushion to the brain and permits considerable mobility of the intracranial contents, but injury occurs when excessive moulding, over-lapping, or sudden changes of pressure occur in the skull during the process of delivery.

The site of the hæmorrhage may be extradural, subdural, subarachnoid or intracerebral.

Extradural hæmorrhage due to rupture of the middle meningeal artery or the veins near the sigmoid sinus is rare in the newborn infant. It may occur with a fracture through the middle temporal fossa or from forcible separation of the cranial sutures.

In cases of tearing of the tentorium cerebelli or of the falx cerebri there may be extradural bleeding, but the blood also escapes into the subarachnoid space, and the symptoms produced are chiefly due to this.

Subdural hæmorrhage takes the form of slow bleeding into the space between the dura and the pia-arachnoid layers and is due to rupture of small veins crossing this space. A subdural hæmatoma slowly forms over a period of some days (see p. 665).

Subarachnoid hæmorrhage is most commonly seen in association with prolonged or traumatic delivery and often arises from a tear of the tentorium or falx, with rupture of small vessels or a dural sinus. Sometimes a massive extradural hæmorrhage is associated with bleeding through the tear into the subarachnoid space. Especially in premature babies, together with gross tentorial tearing there may be rupture of the great vein of Galen, with fatal hæmorrhage.

Intraventricular hæmorrhage. Spontaneous intraventricular hæmorrhage occurs most frequently in premature babies, and is the result of anoxia and congestion of the vessels of the choroid plexus, which give way. It is fatal.

Intracerebral hæmorrhage. These hæmorrhages are often only petechial and are distributed throughout the substance of the brain. Such hæmorrhages are usually associated with severe asphyxial episodes.

Clinical signs. Minor intracranial hæmorrhages must often escape recognition as they do not cause a recognizable clinical pattern and massive hæmorrhages cause stillbirth or almost immediate death. Lesions of intermediate severity create most intricate diagnostic problems in which the usual examination of the nervous system is impossible or misleading.

General symptoms and signs are often strongly suggestive of intracranial hæmorrhage; convulsions, asphyxia pallida, depression of respiration and heart-rate associated with alterations in muscular tone are frequently seen. Cyanosis or unusual pallor, fever, a shrill cry and excessive restlessness, or somnolence, may all occur. An anxious facial expression, an adder-like protrusion of the tongue and unusual yawning should suggest the diagnosis.

The tension of the fontanelle should be noted. In an extensive hæmorrhage the fontanelle may bulge, but is more often doughy in consistency or tense.

Since the tentorium is so frequently the source of the hæmorrhage, it is convenient to differentiate the clinical pictures associated with bleeding above and below this level.

Supratentorial bleeding. This usually affects the surface of the hemispheres and the basal ganglia. The picture is one of irritation with fullness of the fontanelle, convulsions which may be unilateral, and excessive response to stimuli of sound, light and touch. The eyes may roll upwards and the face twitch during these clonic contractions. Adductor spasm may be demonstrated. The vital centres are involved in the terminal stages.

Infratentorial bleeding. This is often associated with early neck rigidity, opisthotonus and alteration in the rate and depth of respiration. Cyanosis is common. The baby tends to be limp and toneless and the vital centres are affected early.

Treatment of cerebral hæmorrhage. It is essential that the infant should be kept quiet and warm and sheltered from any noise or disturbance which might induce further restlessness or convulsions. Avoidance of any unnecessary handling is desirable and should be restricted to essential nursing services. Respiration and full oxygenation must be maintained. These conditions are best achieved by nursing the infant in an oxygen incubator in which optimal conditions of warmth, humidity and oxygen concentration can be provided. Clothing can be reduced to a minimum

inside the incubator and the infant need only be placed on a napkin to collect excreta. The baby should be kept in a quiet and darkened room. The infant should be fed in the incubator and need not be removed for any nursing services. When the baby sucks poorly or refuses feeds, then tube feeding should be given at intervals of 4 to 6 hours.

If an incubator is not available, an ordinary cot in a well warmed room will usually prove an adequate substitute.

Opinion differs concerning the position in which the infant should be nursed. It is claimed that the tendency to further bleeding is reduced when the baby is nursed propped upright on pillows, but the greater comfort to the baby of lying flat probably outweighs other possible advantages.

Phytomenadione (vitamin K_1, Konakion) 0·5 to 1·0 mg. should be given by intramuscular injection to prevent the added complication of hæmorrhagic disease when bleeding has already taken place.

An infant who is restless or has convulsions should be given sedatives until the convulsions are controlled or the restlessness reduced, as these symptoms tend to provoke further bleeding. Chloral hydrate 30 to 60 mg. (gr. $\frac{1}{2}$ to 1), or phenobarbitone 7 to 15 mg. (gr. $\frac{1}{8}$ to $\frac{1}{4}$) may be given by mouth and repeated at intervals of 2 to 6 hours. Paraldehyde 0·25 to 0·5 ml. (4 to 7 ml) by intramuscular injection is probably more effective and appears to be well tolerated.

Lumbar puncture may prove the diagnosis by demonstrating the presence of blood in the cerebrospinal fluid but the disturbance caused to the infant is possibly harmful, and the removal of fluid under pressure may provoke further bleeding.

The administration of 10 per cent saline solution rectally has been recommended in cases in which the intracranial pressure is high and the fontanelle is bulging, since the condition may be due to cerebral œdema rather than to hæmorrhage.

The main principle of treatment is to maintain the condition of the infant as well as possible and avoid any unnecessary disturbance. The prognosis in cerebral hæmorrhage is always in doubt and is usually poor. The infant may survive to show cerebral palsy, convulsions or mental retardation, but complete recovery may follow a subarachnoid hæmorrhage.

Subdural hæmatoma. The subdural hæmatoma usually results from trauma at birth with slow bleeding into the space between the dura and the pia-arachnoid layers, due to rupture of small veins crossing this space. A blood-clot forms and increases in size because of further small hæmorrhages or through the lysis of clot and subsequent absorption of serum from the blood-stream. There is organization of the clot at the periphery with the development of a space occupying lesion.

Clinical symptoms may appear in the days after birth with failure to

gain weight, irregular fever, vomiting and irritability. Coma or convulsions may be seen at this stage, but it is more common to find enlargement of the skull simulating hydrocephalus with fits which appear in the first few months of life. The diagnosis is made by needling of the subdural space through the lateral angles of the fontanelle. The finding of blood-stained or xanthochromic fluid in subdural tap indicates the need for repeated daily aspirations to evacuate the hæmatoma. Surgical removal of the clot and the capsule is usually necessary to avoid the sequelæ of cortical atrophy, due to fibrosis of the pia-arachnoid, namely convulsions, spasticity and mental retardation.   .

Fractures of the long bones. *Clavicle.* The clavicle is the bone which is most frequently broken during delivery, usually during forceps or breech extraction. Dislocation of the fragments, crepitus and hæmatoma are rare and the lesion is usually detected because the infant fails to raise the arm above the head, an absent Moro response in one arm or because of callus formation after a few days. X-ray examination shows a greenstick, oblique or subperiosteal fracture and callus formation is early. The prognosis is good and immobilization of the part is only necessary when marked displacement is present.

Humerus. Injuries may consist of luxation at the shoulder, epiphyseal detachment or fracture of the shaft. Displacement and fracture are often difficult to detect clinically. The usual symptoms are pain and failure to use the arm. Strapping the arm to the trunk gives sufficient fixation.

Femur. The femur is seldom fractured.

In all fractures of the long bones callus formation and healing are usually good, although the maintenance of position may be difficult. The subsequent growth of the bone corrects any angulation and deformity of the bone, but all fractures should be submitted to an orthopædiac surgeon for his supervision.

Trauma to the viscera. Rupture of the liver, spleen or kidneys may occur in difficult deliveries, especially breech extraction, or hæmorrhage may occur into these viscera.

Signs of collapse or internal hæmorrhage will be seen and enlargement of the organ may be discovered, but the diagnostic problem is a difficult one.

When rupture of one of the abdominal viscera or hæmorrhage into the liver, spleen or kidney is diagnosed the infant should be given a blood-transfusion and laparotomy carried out to try to repair the lesion. The mortality is high in such traumatic lesions.

Hæmorrhage into the suprarenals may occur, especially in breech presentations. The infant may be stillborn or die soon after birth with

severe shock and cyanosis. The enlarged adrenal may be palpable and, if the diagnosis can be made, treatment should consist of blood-transfusion and administration of adrenal cortical extract.

Peripheral nerve palsies. *Facial palsy.* These paralytic lesions may be central or peripheral. The central or supranuclear paralysis is very rare and leaves the muscles of the forehead and eyelid unaffected because of their innervation from both hemispheres.

FIG. 230.   Facial paralysis following application of the forceps.

Infranuclear lesions may be extracranial or intracranial, and may be caused by pressure of the forceps blade on the nerve near the stylomastoid foramen or within the parotid gland. In other cases the paralysis may be due to œdema, hæmorrhage or simple stretching of the nerve. Rarely the nerve is affected in a basal fracture affecting the temporal bone. Facial palsy may be seen after forceps delivery or after spontaneous labour.

On the affected side the eye remains open, the corner of the mouth droops and the nasolabial fold is less marked than on the normal side. When the child cries the mouth is drawn to the normal side and the asymmetry of the face is exaggerated.

The treatment is expectant and in the vast majority of cases recovery occurs within a few days. In infants in whom improvement is delayed, electrical stimulation has been recommended. Faradic stimulation is given but is probably not effective.

Brachial palsy. Lesions of the brachial plexus may be due to simple pressure injury above the clavicle and behind the sternomastoid. In the other cases the nerve plexus is damaged when contiguous bony structures are injured. The majority of cases are due to overstretching or tearing of the nerves by traction.

Pressure of forceps blades may produce the lesion, but it results more commonly from difficulty in extraction of the shoulders or from pulling on the arm. Actual rupture of the nerves is rare, but there may be hæmorrhages into the nerve sheath.

The clinical picture depends upon the nerve roots involved. C5 and C6 lesions produce a paralysed arm with internal rotation at the shoulder, clenched fingers and inability to bend the elbow. The arm lies in internal rotation at the side of the trunk or where it is allowed to fall. This syndrome is usually called the Erb-Duchenne paralysis.

If C7, C8 and D1 are affected, there is paralysis of the muscles of the forearm with wrist drop and flaccid digits, and this is called Klumpke's paralysis. Both lesions co-exist when the brachial plexus is involved in its entirety.

If the nerves have merely been compressed or have been stretched, recovery is the usual outcome, but when rupture of a nerve, or severe hæmorrhage into the sheath has taken place, the paralysis is permenant.

Treatment is expectant, but the arm must be placed in the position which avoids stretching of the affected muscles and pull on the nerves. The arm is elevated and maintained in abduction and external rotation, with the upper arm at right angles to the trunk, the elbow bent to 90 degrees and the wrist in extension. Plastic splints should be made to achieve this position, but first aid treatment is to fasten the back of the hand to the back of the head, or to the top of the cot with a loose bandage. Massage and manipulation is started early and electrical stimulation is sometimes employed after the 4th week. In cases which do not improve, surgical opinion should be obtained for consideration of open operation on the nerves. In cases which do not show early improvement the prognosis for complete recovery is not good.

DISTURBANCES OF THE DIGESTIVE SYSTEM DURING THE NEONATAL PERIOD

Vomiting. Vomiting is a relatively frequent symptom during the neonatal period and may arise from a variety of causes, the majority of which are not of serious consequence. However, other causes may have a serious significance and this symptom must never be treated lightly.

Mucous vomiting. Many infants vomit mucus, which may be blood-stained, during the first few hours after delivery. This may persist after

feeding has started and the amount of mucus in the vomit may be copious. The probable explanation is that the gastric mucosa has been irritated by material swallowed at the time of delivery with the production of an irritative gastritis.

No abnormality can be detected on physical examination, but the vomiting may be troublesome and the initial weight loss excessive.

If the vomiting is severe or persistent, treatment consists of gastric lavage with normal saline until the wash-out is clean. This may require to be repeated on several occasions until the condition settles.

Overfeeding. Vomiting is sometimes due to the taking of a greater quantity of food than can be retained in the stomach and the excess is regurgitated. Failure to make the baby bring up the wind after feeds often causes vomiting as the milk is brought up with the swallowed air after the baby is laid in the cot. In both instances the treatment is obvious.

Obstructive vomiting. Vomiting which commences shortly after birth and is persistent raises the possibility of an obstructive lesion of the gastrointestinal tract. The vomiting is frequent, non-projectile, copious and usually bile-stained, unless the obstruction is above the level of the ampulla of Vater. Bile-stained vomit always demands consideration as a symptom of an obstructive lesion. Abdominal distension, visible abdominal peristalsis and failure to pass meconium are usually present, and are associated with a progressive loss of weight and deterioration in the general condition of the infant. These symptoms demand immediate radiological investigation, and consultation with a surgeon as soon as obstruction is diagnosed. Plain X-rays of the abdomen should be taken with the infant erect and supine and will show the dilatation of the gut with fluid levels which are characteristic of obstruction. These films will yield sufficient evidence of the condition, and it is neither necessary nor desirable to use opaque media such as barium for the localization of the obstruction, as this may complicate surgical treatment and after care. Possible causes of obstruction which should be borne in mind are œsophageal atresia, duodenal stenosis or atresia, ileal atresia or meconium ileus.

Tracheo-œsophageal fistula or atresia. Œsophageal atresia, with or without tracheal fistula, occurs relatively infrequently, but delay in diagnosis reduces the chances of survival. The possibility must be borne in mind in every infant who shows difficulty with the first feeds. The association with hydramnios is sufficiently frequent to make it a rule to investigate every baby for atresia soon after birth if hydramnios has been present.

Œsophageal atresia results in an absence of the œsophageal lumen at the level of the bifurcation of the trachea. Simple atresia is relatively uncommon and there is usually an associated tracheal fistula which may arise from the upper or the lower œsophageal pouch, rarely from both.

The initial symptom is invariably difficulty with the first feed. In simple atresia regurgitation of the fluid taken and inability to keep the mouth clear of saliva should raise suspicion. When the upper pouch communicates with the trachea through a fistula, the first feed causes choking and cyanosis and requires immediate clearance of the oro-pharynx. In cases where the lower pouch communicates with the trachea, regurgitation of acid secretions from the stomach to the trachea causes pneumonia, usually of the right middle lobe, and the usual symptoms of swallowing difficulty.
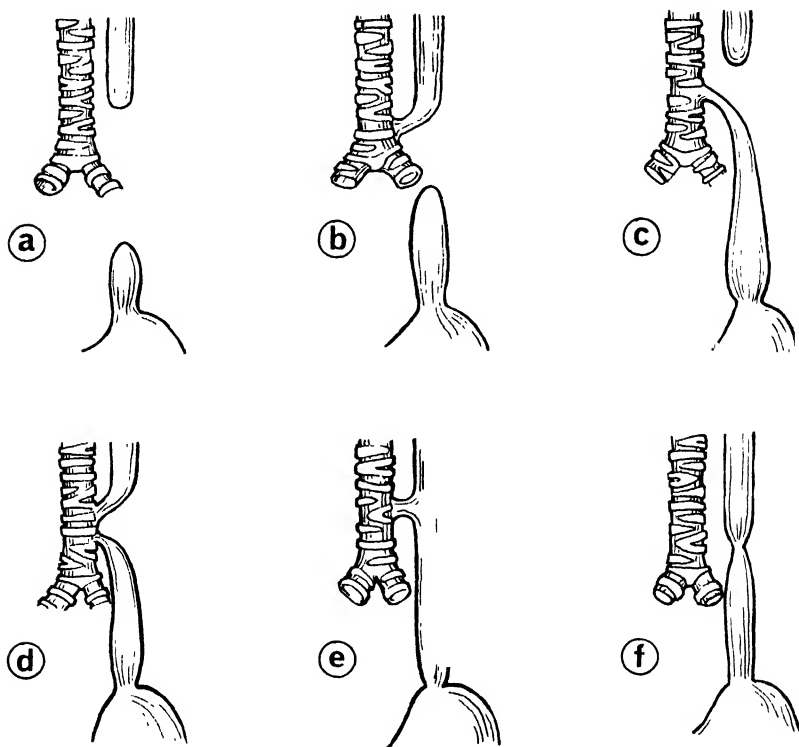
FIG. 231. Congenital lesions of the œsophagus. A. Œsophageal atresia without fistula. B. Œsophageal atresia with fistula from upper pouch. C. Atresia with fistula from lower pouch. This lesion is found in 90 per cent of cases. D. Atresia with double fistula. E. Fistula from œsophagus with continuous lumen. F. Œsophageal stenosis.

The signs to be found depend on the presence of a fistula and its site. The upper pouch fistula, with its suffocative symptoms in swallowing, should raise immediate suspicions. Examination of the abdomen will show absence of gastric air as the lower pouch of the œsophagus is blind. A lower pouch fistula will show the same difficulty in swallowing feeds and clearing

saliva, but as the lower pouch communicates with the trachea through a fistula, gastric air will be present and chest signs will soon develop.

Any suspicion that swallowing is not normal should lead to prompt investigation by an attempt to pass a stiff catheter through the œsophagus to the stomach. The use of a soft catheter may permit the catheter to coil around in the pouch above the atresia and delude the observer into believing that it has passed to the stomach. The aspiration of acid secretion and the emptying of the stomach of air provide proof that the œsophagus is patent. Failure to pass the catheter more than half-way down the œsophagus proves the presence of œsophageal atresia.

If doubt still exists, the installation of 2 ml. of lipiodol down the catheter and X-ray in the erect position will demonstrate the presence of œsophageal atresia and a fistula from the upper pouch.

Surgery offers a good chance of survival in the larger infants. The choice of surgical approach depends on the type of lesion and the maturity of the infant.

As soon as the diagnosis is established the infant should be transferred for pædiatric surgical care with an indwelling œsophageal catheter and frequent suction to empty the upper pouch. All feeds should be withheld.

Diaphragmatic hernia. The congenital failure of development of one side of the diaphragm presents a difficult diagnostic problem and is often undiagnosed during life. The failure of development of the diaphragm, usually on the left side, causes a defect in the muscular leaves, through which the abdominal contents herniate into the pleural cavity. Most commonly such herniæ cause severe cyanotic attacks due to trapping of airfilled viscera in the chest, and vomiting is usually present. The diagnosis may be shown by the abnormal gut sounds heard in the chest, but usually the diagnosis is made by X-ray examination which shows gut in the pleural cavity.

These infants require immediate surgery, and should be transferred to surgical care with a tube passed to the stomach by which the latter can be deflated. It is wise to intubate the trachea so that assisted respiration can be given should the airfilled viscera in the pleural cavity cause collapse of the lung and deep cyanosis.

Eventration of the diaphragm. Occasionally the diaphragm fails to develop the normal musculature and remains as a non-contractile fibrous structure. While this separates the abdominal and pleural cavities, the diaphragm is pushed high into the chest and the abdominal capacity increases at the expanse of the chest. Gut sounds are heard in the chest, the lung is poorly expanded, and the infant is cyanotic. X-ray shows the abnormal position of the diaphragm. Some infants succumb and others survive with frequent chest infections.

Hiatus hernia. Herniation of the cardiac end of the stomach through an œsophageal hiatus in the diaphragm may cause vomiting. The infant regurgitates small amounts from one feed to another and fails to thrive. The condition is demonstrated on barium swallow and the actual variations of the lesion may be seen. Often, no hiatus hernia can be demonstrated and the diagnosis of 'easy œsophageal reflux' or 'lax cardia' is made.

Treatment is symptomatic. Thickening the feed, and propping the infant in his cot at 45 degrees are usually sufficient to relieve the symptoms and permit the baby to gain weight.

Congenital atresia of the gut. Duodenal atresia or stenosis causes vomiting, failure to void meconium and upper abdominal distension. The vomit is usually heavily bile stained. Plain X-ray of the abdomen in the erect position shows a 'double bubble' of gas in the stomach and in the duodenum with an empty gut beyond. The lesion is frequently associated with Mongolism. Treatment is surgical.

Ileal atresia. Single, or frequently multiple, atretic lesions of the small gut present with vomiting, delay in the passage of meconium and abdominal distension. Plain X-ray of the abdomen in the erect position shows the characteristic gaseous distension of the bowel above the lesion with fluid levels. X-ray does not always determine the site of the lesion and laparotomy should be undertaken urgently, the surgical treatment being dependent on the findings at operation.

Meconium ileus. This represents a special variety of obstruction of the terminal ileum. The patient basically suffers from mucoviscidosis with absence of pancreatic enzymes in the bowel during intra-uterine life. The meconium is not normally digested and is packed in the lower ileum, putty-like in consistency and appearance. The obstruction presents with the usual symptomatology. X-ray of the abdomen may show an obstruction with gaseous distension and fluid levels in the small bowel, but a lack of gas and a finely mottled opacity in the right lower quadrant. Surgical treatment often requires resection of bowel and, at best, removal of the abnormal meconium from the ileum. Subsequently the infant must receive full treatment for mucoviscidosis.

Congenital hypertrophic pyloric stenosis. The development of symptoms from the obstruction caused by hypertrophy of the circular muscle of the pylorus is not common before the 2nd week of life. Male infants are affected by this condition more frequently than are females, the ratio between the sexes being 5 to 1. The symptoms are projectile vomiting, a failure to gain weight and constipation. The infant usually feeds eagerly despite the projectile vomiting which occurs at the end of feeds and will

usually accept re-feeding immediately after having vomited. The vomitus does not usually contain bile.

With the continued vomiting, the condition of the infant deteriorates and he becomes dehydrated with loss of skin turgor, depression of the fontanelle and dryness of the mouth. The loss of chloride in the vomit causes a low plasma chloride level and a compensatory alkalosis.

Careful examination, with the baby well relaxed during a feed, reveals visible gastric peristaltic waves and a palpable pyloric tumour. The condition may be treated medically or by operation. Medical treatment lies mainly in the use of stomach wash-out, small easily digested feeds given at frequent intervals, and the administration of drugs to relax the spasm which may exist at the hypertrophic pylorus. Atropine methyl nitrate (Eumydrin) is given 10 to 15 minutes before the feeds. The drug may be given as lamellæ containing o·o8 mg. (gr. 1/750), as an aqueous solution of 1 in 10,000 strength in doses of 1 to 5 ml., or as an alcoholic solution (o·6 per cent) in doses of o·1 to o·2 ml. Alternatively scopolamine methyl nitrate (Skopyl) may be used. This contains 2·5 mg. in 3 ml. of solution, and 1 to 3 drops are given sublingually 15 minutes before feeds with, a maximum of 18 drops (1 ml.) in 24 hours.

Surgical treatment by Rammstedt's pyloroplasty offers a rapid relief of the condition and carries a low mortality in experienced hands. Although opinion is widely divergent on the relative merits of medical and surgical treatment, the latter appears to be preferable whenever experienced surgical and nursing facilities are available.

Pylorospasm. Some infants present with projectile vomiting similar to that seen in pyloric stenosis, but without evidence of permanent obstruction or a palpable tumour. Relief may be obtained from the use of sedatives or antispasmodics.

Other causes. Vomiting may be a symptom of intracranial lesions with increased intracranial pressure or cerebral irritation, or may occur with infection in any system of the body. Vomiting may be the initial and often the only sign of an infection during the neonatal period, and is often accompanied by diarrhœa. It cannot be too strongly emphasized that vomiting and reluctance to feed are often the earliest symptoms of infections such as pyelonephritis, meningitis or other severe illnesses and are symptoms which must never be lightly disregarded.

Diarrhœa

Diarrhœa is sometimes diagnosed without justification because of ignorance of the normal variation in bowel habit of the healthy infant, but frequency of stool is not necessarily pathological.

The passage of frequent loose and watery stools, usually containing the curds of undigested milk, and often green in colour due to unchanged bile, is evidence of hurry through the gut. The presence of mucus suggests irritation of the intestinal mucosa, and blood in the stool is suggestive of infection. Colic and screaming often accompany the diarrhœa, and signs of dehydration such as loss of skin turgor, loss of weight, and a sunken fontanelle are found early.

The most common causes of diarrhœa are:

(a) Errors in feeding, either in the quality of the food or in the amount which is given.

(b) An excess of sugar in the feed causing fermentation in the gut.

(c) Infection of the gastro-intestinal tract by bacteria or viruses.

(d) Parenteral infection elsewhere in the body.

Feeding irregularities. If the feeding of the newborn infant is increased too rapidly in the amount which is given, or in the strength of the feeds, the gut may respond by a hurried transit of its contents and the production of frequent loose stools. Excessive fat content in artificial feeds, or too generous an addition of sugar, may be especially to blame. When loose stools have been caused by such errors, relief may be obtained by reducing the strength of the feed for a period of 24 hours. Once the diarrhœa has ceased the feeds may be gradually increased in strength during the next few days. In more severe cases, a period of 24 hours on water alone, or $\frac{1}{4}$N saline in 5 per cent glucose solution, before the reintroduction of milk may be necessary to restore the stools to normal. If any doubt exists as to the severity of the condition, it is usually best to eliminate milk from the diet at once and see how quickly benefit is obtained.

Excess of sugar in the feed. Some dried milks contain a high carbohydrate content and by causing fermentation may induce a looseness of stool. Diarrhœa due to excess of carbohydrate is often frothy and the stools are very irritative to the buttocks. Colic and sore buttocks are frequently seen. The remedy lies in a change of feed to one with a lower sugar content.

Infection of the gastro-intestinal tract. Diarrhœa due to the dysentery group of organisms is uncommon in the neonatal period. Occasionally infections with coliforms and other organisms of relatively low pathogenicity may occur. Contamination of feeds with staphylococci is possible, and if fresh milk is not sterilized infection with a great variety of bacteria may occur. In maternity nurseries epidemics of diarrhœa among newborn infants may be due to virus infections. Bacterial infection is usually accompanied by vomiting, diarrhœa, and anorexia. The infant is usually but not always febrile; a few cases may be prostrated with sub-normal

temperature. The stools are loose, watery and undigested. They may contain mucus, pus cells and red cells. The infant will fail to gain or may lose weight, and in severe cases dehydration rapidly appears and the condition of the infant is usually poor. Acidosis, with a low alkali reserve, is frequently seen.

Infants presenting these symptoms should be isolated from all other babies immediately, and in institutions should be nursed with full barrier precautions. Milk feeding should be stopped and the infant given quarter normal saline or Hartman's solution in 5 per cent glucose instead. Feeds should be given frequently in small amounts at intervals of 2 or 3 hours, and the total daily intake should be approximately 3 ounces per pound bodyweight, the excess being necessary to make good the additional fluid loss caused by the diarrhœa. Should vomiting persist, or the baby become further dehydrated despite this treatment, it will be necessary to give fluids by intravenous infusion, the type of fluid being dictated by electrolyte estimations.

Stool cultures must be taken at the onset to determine the infecting organism and sensitivities to antibiotics. Antibiotic therapy must be started without awaiting the result of these tests (see p. 696). The prognosis in such cases must always be guarded until the response to treatment is seen.

Epidemic diarrhœa of the newborn. In other cases the baby with symptoms of a gastro-intestinal infection may fail to show pathogenic bacteria on stool cultures and a virus ætiology must be postulated. The symptoms may not be severe but the loose stools and low grade fever with failure to gain weight may persist for a week or more. The stools tend to be watery, yellow and acid, but seldom contain mucus, pus cells or blood. The stools are voided in explosive fashion.

The condition of the infant may deteriorate rapidly and the need for rehydration may become urgent. The condition may improve only to relapse during treatment, and the infant may develop intercurrent infections of the lungs, ears or septicæmia.

The infectivity is high and the disease may spread in nurseries in epidemic form. Isolation and full barrier nursing is essential as soon as the diagnosis is suspected.

The treatment is symptomatic. Initial cessation of milk feeding, with oral, subcutaneous or intravenous administration of electrolyte containing fluids to combat dehydration and acidosis, form the basis of therapy. When diarrhœa ceases a gradual return to feeding may be made.

Parenteral infections. Diarrhœa and vomiting may be symptoms of infection outside the gastro-intestinal tract, such as pyelitis. A search for

such an infection must always be made when diarrhœa occurs and the diarrhœa will cease when the infection is brought under control.

Colic. Colic is manifest by screaming, flushing of the face, clenching of the fists, flexing of the legs and arms and tenseness of the abdominal wall. The common causes are distension of the gut with wind or spasmodic contractions of the gut due to some irritative stimulus. Swallowing of air and failure to de-wind is the most common cause, but improper feeding or some mechanical obstruction such as volvulus or intussusception may occur.

Treatment during an attack should be directed to removing the cause. The bringing up of wind, the passage of flatus or a motion, and the application of warmth to the belly may afford relief. Elimination of the cause, whether it is ærophagy or improper feeding, will prevent recurrence in most cases.

Constipation. True constipation in the newborn infant is comparatively rare. Cases of obstruction such as gut atresia present as emergencies and should be treated appropriately. Hirschprung's disease does not often give rise to marked symptoms during the neonatal period, although delay in the passage of the first meconium, vomiting and abdominal distension may be the earliest signs of these conditions. A plain X-ray film of the abdomen shows gas throughout the gut and a barium enema demonstrates that the lower bowel is patent. Evacuation of the barium at this age is usually normal. Submucous rectal biopsy may demonstrate the absence of ganglion cells. Colostomy may be required for the relief of Hirschsprung's disease.

Constipation in this age group is usually a variation in the normal bowel habit, and the passage of hard motions at irregular intervals is most commonly the result of insufficient intake of fluid or food, or the use of artificial feeds which are too rich in protein or too low in sugar content. Underfeeding in the first week of life may cause the passage of infrequent hard stools.

Treatment should be directed to the correction of the dietetic error and the administration of extra water. More severe constipation may be relieved by a glyccrine suppository, the old-fashioned soap stick or by a small water enema. Purgatives and aperients are to be deprecated, even the mildest such as milk of magnesia. As the cause is nearly always an indaequacy of diet or fluid intake, it is rational that the treatment should be by correction of this error.

HÆMORRHAGIC STATES IN THE NEWBORN

Hæmorrhagic disease of the newborn. This condition shows in an unusual tendency to spontaneous and prolonged bleeding in the first week

of life, usually from the 2nd to the 5th day. The common site of hæmorrhage is the gut, but the lungs, brain, skin, mucous membranes, umbilical cord and vagina may be affected. The bleeding coincides with the period of low prothrombin level which occurs in the newborn infant from the 2nd to the 7th day, when the level may fall to 20 per cent of normal, but some other factor must also be involved. Bleeding and clotting time and platelet level may be abnormal, and the prothrombin level is reduced when the condition exists. The prothrombin may be restored to normal by the administration of vitamin K, but not every case of hæmorrhagic disease responds to this treatment. In such instances a small fresh blood-transfusion arrests the hæmorrhage. Excessive administration of vitamin K should be avoided, as it increases the liability to jaundice. It is unnecessary to give more than 1 mg. in most cases, although this may have to be repeated the next day.

The clinical signs and symptoms depend on the system involved, but the condition presents most commonly as vomiting of blood, or melæna.

Because of the possibility of the occurrence of this condition, which is not common, it is wise to avoid elective surgery such as circumcision in the newborn before the 8th day of life. If surgery is necessary, phytomenadione (vitamin K_1, Konakion, 0·5 to 1 mg. intramuscularly) should be given daily until the pro-thrombin level is normal. Fresh blood should be available in case bleeding is not controlled by vitamin K administration.

Umbilical bleeding. This is most frequently due to a slipped ligature during the first 24 hours, or to infection of the stump once the cord has separated. A brisk umbilical hæmorrhage may endanger life as every ounce of blood lost is equivalent to approximately 10 per cent of the baby's total blood-volume. It may be possible to stop the hæmorrhage by tying a fresh ligature around the cord. If the cord has separated, the bleeding point may be brought under control by pressure or it may be possible to stop the bleeding with a pair of artery forceps. Urgent transfusion may be required in cases in which umbilical bleeding occurs. The total blood-volume of the newborn infant is only about 10 ounces and a loss of blood amounting to 2 ounces may constitute a dangerous hæmorrhage.

Hæmophilia. This is a very rare cause of neonatal bleeding, especially after circumcision.

Thrombocytopenic purpura. A congenital thrombocytopenia is sometimes seen with a petechial rash, ecchymoses and bleeding. This should be differentiated from simple traumatic purpura of the head and neck due to pressure. If doubt exists a platelet count will be found to be low in thrombocytopenia. The infant is frequently affected when the mother has had thrombocytopenic purpura during pregnancy. Most cases

resolve after a short time but it may be necessary to treat the infant with steroids.

Anæmia in the newborn infant. The most common cause of anæmia at birth is hæmolytic disease of the newborn, but otherwise it is usually the result of hæmorrhage. Hæmorrhage may occur from tearing of the cord during delivery, incision of the placenta during Cæsarean section or from bleeding from the placenta from the fœtal side during delivery. The infant will be pale at birth and the hæmoglobin will be low. Transfusion may be required in severe cases.

Bleeding from the infant into the maternal circulation occurs across the placenta and may be proved by the demonstration of fœtal cells in the mother's blood. This is not usually of such a degree to cause anæmia in the infant, although it may be so on rare occasions.

Occasionally in twin pregnancies with a shared placenta, one twin may lose blood into the circulation of the other twin. A marked contrast in the colour of the twins may be noticed and blood investigation show poly-cythæmia in one baby contrasting with the anæmia in the other.

Vaginal bleeding. A vaginal loss is not infrequent and is not serious unless it is due to hæmorrhagic disease. A more usual cause is a hormone withdrawal effect, when no active treatment is necessary, and the condition is often referred to as neonatal menstruation.

JAUNDICE IN THE NEWBORN INFANT

Jaundice in the neonatal period may be due to a variety of causes.

Physiological jaundice or icterus neonatorum simplex. At birth the baby has a high hæmoglobin level and red cell count. The normal values at birth are hæmoglobin 120 to 140 per cent and a red cell count up to 6 million per c.mm. This polycythæmia is necessary *in utero* to ensure adequate oxygen-ation *via* the placenta, but once normal respiration is established, the extra red cells are unnecessary and a rapid fall in hæmoglobin and red cell count takes place during the first week of life. The red cells are destroyed and the iron is stored in the liver. The bilirubin formed is normally excreted by the liver but, if a relative immaturity of the liver co-exists, with low levels of the enzyme glycuronyl transferase, the liver cannot conjugate the indirect reacting bilirubin, and therefore cannot eliminate the bilirubin from the plasma and jaundice occurs.

Physiological jaundice usually appears on the 2nd or 3rd day of life and may last for only a few days or until the 10th day. The skin is lemon yellow in colour, but the conjunctivæ show staining only in severe cases.

The liver and spleen are not increased in size and the stools remain normal in colour. The jaundice is not associated with fever or constitutional upset, although the infant may be sleepy and less eager for food. No special treatment is required and the prognosis is entirely favourable, except in small premature infants when kernicterus occasionally occur if the bilirubin rises above 20 mg. per 100 ml. In such babies replacement transfusion is indicated. The bilirubin level rises slowly and usually reaches a maximum between the 4th and 8th days after birth.

Sepsis. Sepsis, especially when accompanied by septicæmia, is a cause of jaundice and anæmia appearing after the first few days of life. The signs, symptoms and treatment are those of the primary infection.

Syphilis. Congenital luetic infection may cause a syphilitic cirrhosis with jaundice.

Congenital atresia of the bile ducts. This developmental anomaly is rare and may be partial or complete. Jaundice appears at the end of the 1st week of life or later and is said to be of olive green hue. The liver progressively enlarges and becomes firm and the stools become white, while the urine contains bile. These patients should always be submitted to laparotomy as about 15 per cent of cases have an extra-hepatic atresia which is reparable surgically. The condition is otherwise progressive and has a fatal outcome although the infant may live for many weeks or months.

Congenital spherocytic anæmia (acholuric jaundice). Rarely the hæmolytic anæmia of congenital spherocytosis causes jaundice in the neonatal period.

Congenital toxoplasmosis. Mothers who have suffered an occult infection with the protozoan parasite *Toxoplasma gondii* may give birth to infants affected by a congenital form of the disease. Internal hydrocephalus, choroidoretinitis, fits and mental retardation may result. If the infection has been shortly before birth, the baby may have hepatosplenomegaly and jaundice, or jaundice of persistent type may be the sole symptom. Diagnosis is made by serological tests on mother and child, the complement fixing and dye modifying antibodies being most valuable. There is no effective treatment.

Virus or neonatal hepatitis. Jaundice, hepatomegaly and an ill baby may be the signs of a virus hepatitis in the newborn infant. The viruses of infective hepatitis or herpes simplex have been incriminated. The mother may have shown a clinical illness or had an inapparent infection. The infant,

if affected, is usually severely ill and the outcome may be fatal, or may lead to cirrhosis of the liver during infancy.

Glucose-6-phosphate dehydrogenase deficiency. The genetically determined deficiency of this enzyme which is essential for the survival of erythrocytes is not uncommon in Asiatics and the Mediterranean races. Spontaneous destruction of red cells in the neonatal period may cause an enhanced apparently 'physiological' jaundice, but the hæmolysis may be precipitated by the administration of various drugs to the infant.

Cretinism. A prolonged neonatal jaundice without any obvious cause, especially in an apathetic anorexic infant, should raise the suspicion of cretinism.

Hæmolytic disease of the newborn (Icterus gravis neonatorum; Erythroblastosis fœtalis).

Landsteiner and Wiener in 1940 showed that the red cells of 85 per cent of white people contain an agglutinogen which they named the rhesus factor because of the similarity to an antigen found in the red cells of the *Rhesus macacus* monkey. Individuals possessing this factor are called Rh-positive and the remainder Rh-negative.

Transfusion of Rh-positive blood to an Rh-negative recipient stimulates the production of an agglutinin in the recipient's serum called the anti-Rh antibody. This is a true agglutinin, and if a second transfusion of Rh-positive blood is given to a sensitized individual the agglutinin already present in the patient's serum causes agglutination and hæmolysis of the transfused cells. Such transfusion reactions are severe and often fatal.

Rhesus factor in pregnancy. The rhesus factor is not a single antigen but a complex of genes inherited as a triple allelomorph, usually represented by cC, dD and eE.

For all practical purposes this complexity may be ignored and individuals classified as Rh positive or negative, according to whether their cells contain the D antigen or not, as D is the offending antigen in almost every case.

An additional complication exists in the occurrence of homozygous and heterozygous Rh-positive individuals. Obviously the homozygous Rh-positive father must contribute the Rh-positive gene to all his offspring, while the heterozygous Rh-positive father will have an equal chance of having an Rh-positive or Rh-negative baby by an Rh-negative woman.

Sensitization of the mother. The rhesus positive fœtus carried in the womb of the rhesus negative mother may pass the rhesus antigen across the placental barrier into the serum of the mother as the result of fœtal bleeding into the maternal circulation. The foreign antigen will provoke the rhesus negative mother to produce rhesus antibodies, and these in turn

are passed back across the placenta to attack the rhesus positive red blood-cells of the baby. This results in agglutination and destruction of the fœtal cells during intra-uterine life.

The incidence of the disease is not greater than 1 in 125 births and may be much less than this figure.

The chances of marriage between a rhesus positive man and a rhesus negative woman are 11 per 100 in white populations It has been demonstrated that only 5 per cent of rhesus negative women actually become sensitized to the rhesus antigen through pregnancy and produce antibodies. Transfusion with rhesus positive blood will produce sensitization in nearly 50 per cent of rhesus negative women.

The first baby produced by the mating of a rhesus negative woman and a rhesus positive man very rarely suffers from hæmolytic disease of the new-born unless sensitization has been caused by a previous transfusion or by a miscarriage. The second infant may be affected in about 5 per cent of cases, and in subsequent pregnancies the likelihood of affected babies increases with each pregnancy, although the outlook is greatly improved if the father is heterozygous.

Various factors appear to influence the likelihood of sensitization. The different Rh positive genes, of which there are at least 7, appear to have different ability to provoke antibody production in the mother. Differences in placental structure permit greater or lesser leakage of the antigen into the maternal circulation and different women appear to vary considerably in their ability to produce anti-rhesus antibodies in response to the same stimulus. The degree to which the mother is affected by this process can be measured to some extent by estimating the titre of antibodies in the serum during pregnancy when a rise in antibody titre usually indicates an active sensitization.

The first pregnancy of such a mating hardly ever stimulates the production of antibodies but labour may do so. These antibodies, which may be found during the puerperium, persist in the maternal serum after term, and the next Rh-positive fœtus causes further antibody production to a level which may produce hæmolytic disease in the fœtus. In such cases, subsequent pregnancies almost invariably result in severely affected babies. The exception occurs when the father is heterozygous and chance may produce a rhesus negative baby in the middle of a series of affected ones. Rhesus incompatible blood-transfusion appears to carry a greater power to produce antibodies in the woman than does a pregnancy with a Rh-positive fœtus, and following this transfusion every subsequent infant may be severely affected.

Management of hæmolytic disease. No female, from the moment of birth to the end of the child-bearing period, should be given a

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blood-transfusion or whole blood injections without determining her rhesus group and rhesus compatible blood must be used for the transfusion. Even in infancy, the administration of Rh-positive blood to a Rh-negative female may sensitize her to antibody production and jeopardize her chance of ever bearing a healthy infant. In an emergency, when rhesus grouping cannot be done, Rh-negative blood should be given.

Every pregnant woman should have her rhesus blood-group determined as part of the antenatal care. Rhesus negative women should be tested for antibodies at the 12th and 30th week of pregnancy when the presence of antibodies will indicate the possible involvement of the foetus with haemolytic disease.

It is unusual for the baby to be affected in the first pregnancy, but if subsequent mating of a Rh-positive man and a Rh-negative woman is proposed, trouble may be anticipated. The father should be grouped to try and determine if he is homozygous or heterozygous as this will influence the prognosis for a successful outcome of the pregnancy.

In second or later pregnancies, serial estimation of the antibodies may give some indication by a rise in titre whether the baby is likely to be affected, but the degree of involvement of the foetus is not directly related to the antibody titre. In any pregnancy in which antibodies are present, preparations to treat an affected baby should always be made in advance and the delivery should be conducted in hospital. A second or third pregnancy following the birth of an affected infant may result in the intra-uterine death of the foetus. Subsequently the chance of a live-born infant at term are small if the infant is Rh-positive, possibly only 10 to 20 per cent. To try and secure a live infant in such a sensitized pregnancy it is usual to induce labour before term, and depending upon the prognosis this may be done at the 37th or 35th week, or even earlier in severely affected cases. Study of the rise in maternal antibody titre or of the bilirubin in amniotic fluid obtained by amniocentesis may be of value in reaching a decision.

Clinical features of haemolytic disease. The basic process in haemolytic disease is agglutination and haemolysis of the foetal cells by the antibody passed across the placenta from the maternal serum. This blood destruction is balanced by a hyperplasia of erythropoietic tissue in the foetus, both medullary and extra-medullary, to maintain a normal cell count. The result of the pregnancy depends on whether the production of cells can keep pace with the destruction, and on the severity of the haemolytic process. In mildly affected cases, the baby at birth appears normal. After several hours or days, jaundice, anaemia and hepato-splenomegaly may appear.

In more severely affected infants the liver and spleen may be enlarged at

birth and jaundice and anæmia appear almost at once. The anæmia and jaundice may develop rapidly and to a profound degree; death may occur within a matter of hours from the severe degree of anæmia. Jaundice is rarely present at the time of birth although the liquor and the surface of the skin may be stained yellow.

In the most severe cases, the infant may be stillborn, or death may occur *in utero* before term with generalized œdema of the fœtus (hydrops fœtalis).

Hæmatological study of the infant at birth by examination of the cord-blood confirms the diagnosis and indicates the severity of the involvement by the hæmolytic process. The following tests should be carried out on a sample of cord blood obtained at the time of delivery.

Cord-blood hæmoglobin. In affected babies the cord-blood level of hæmoglobin may be normal with levels of 100 per cent or above and the infant may develop anæmia and jaundice after an interval of some hours. These are mild cases. In severely affected infants the hæmoglobin level at birth may be low and values at any level from the normal figure down to 15 per cent may be found.

Rhesus groupings. Rhesus grouping of the cells of the infant will confirm whether rhesus incompatibility is present, and the antibody titre of the serum should be determined. The Coombs test will show whether the infant's red cells have been sensitized by absorption of globulin, i.e. antibody. A positive Coombs test indicates that hæmolysis will occur and the strength of the Coombs reaction indicates the probable severity of the hæmolytic process.

Nucleated red cell count. High erythroblast counts indicate a considerable hyperplasia of the marrow and indicate that extensive intra-uterine hæmolysis has occurred. A low erythroblast count with considerable anæmia at birth suggests marrow exhaustion.

Serum bilirubin levels. The serum bilirubin levels are raised in affected babies and a cord bilirubin level above 2·9 mg. per 100 ml. is an indication for exchange transfusion.

Treatment of hæmolytic disease of the newborn. The problem of treatment lies in the fact that the affected baby at birth has a proportion of his red cells already sensitized by antibodies and destined for destruction. His serum contains a certain quantity of antibodies which will destroy further red cells and this process will continue until all antibodies have been absorbed or eliminated. The destruction of the red cells causes an anæmia which over-production by the marrow attempts to restore, and the survival of the infant is dependent on whether destruction or production is the greater. At the same time the hæmolysis of the erythrocytes causes progressive jaundice which can itself be lethal.

The treatment of the affected baby depends on the severity of the condition. The clinical state of the infant at birth, the cord blood level of hæmoglobin and bilirubin, the strength of the Coombs test and the previous obstetric history of the mother are the factors which must be considered.

When the infant appears normal at birth, without anæmia, splenomegaly or a raised cord blood bilirubin, and the Coombs test is only slightly positive it is obvious that the baby is only mildly affected. Immediate treatment is unnecessary and the infant is watched carefully for the appearance of jaundice or the development of anæmia. If these appear and increase progressively, then it may be necessary to carry out a replacement transfusion. Many such infants require no treatment at all, while others slowly become anæmic, without showing jaundice and require a simple transfusion with rhesus negative blood to correct the anæmia.

The infant who is moderately or severely affected at birth is usually pale, with enlargement of the liver and spleen. Jaundice develops within a short interval after birth and rapidly deepens. It is for these infants that exchange transfusion is essential.

The indications for the use of exchange transfusion immediately after birth have been variously stated. A rather conservative view suggests that replacement transfusion is indicated if:

1. The cord blood hæmoglobin is below 95 per cent.

2. The cord blood bilirubin is greater than 2·9 mgm. per 100 ml.

3. The Coombs test is strongly positive.

4. The infant is affected and there is a history of a previously affected baby.

Technique of exchange transfusion. Under full aseptic technique a polyvinyl catheter is introduced into the umbilical vein and passed so that the tip reaches the portal sinus. By means of a system of three ways tap and a syringe (see Fig. 232) blood may be withdrawn from the vein in 10 or 20 ml. volumes and replaced with equal volumes of rhesus negative blood. By this technique the sensitized red cells of the baby are removed and are replaced by rhesus negative red cells which will not be affected by the antibodies in the serum and will survive.

The alternate removal and replacement of samples of blood will also remove circulating antibodies and bilirubin from the serum. The exchange of blood should be continued until a total volume of 160 ml. of blood per kg. body-weight has been removed and replaced. This will effect a 90 to 95 per cent exchange of the infant's cells.

The detailed technique of replacement transfusion varies from one operator to the next and will not be described. Certain general points should be noted. The infant must not become chilled during the operation. The pulse rate, respirations and activity of the baby should be carefully monitored throughout the procedure and if signs of distress appear the

transfusion must be stopped at least temporarily until the infant's condition is restored.

In severely anæmic infants, or when the umbilical vein pressure is above 6 cm. of blood, it is wise to carry out the exchange transfusion after having removed 10 to 30 ml. of blood before starting the alternate removal and replacement of aliquot volumes of blood. This deficit is restored slowly at the end of the transfusion.
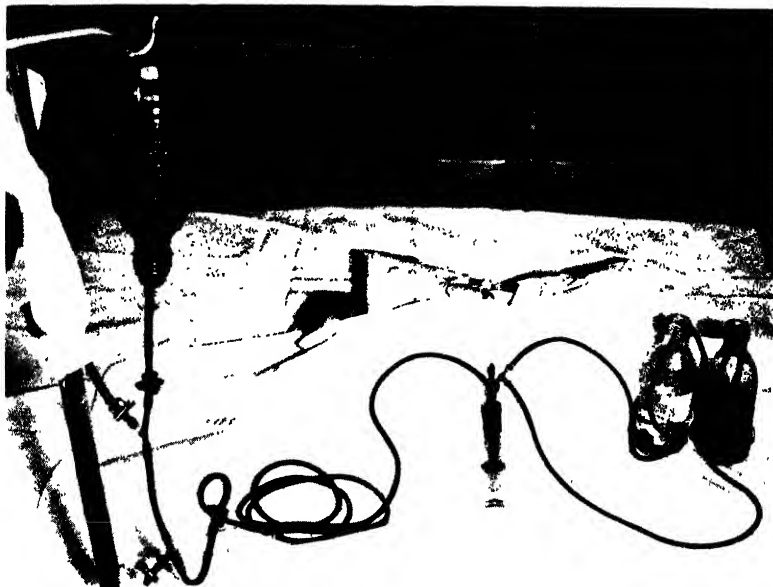
FIG. 232.   Apparatus for exchange transfusion.

Fresh blood is always preferable to stored blood because of the high level of potassium in the plasma in the latter. When citrate has been used as the anticoagulant in the donor blood, calcium gluconate 10 per cent solution (0·5 ml.) may be given through the catheter at the end of each 100 ml. of injected blood to counteract the toxicity of the citrate transfused. Donor blood may also have plasma withdrawn to give a packed cell volume of 50 per cent, as this leaves the infant with a higher final hæmoglobin level.

If exchange transfusion is carried out, the chances of survival are good. After a successful exchange transfusion the baby may show no further symptoms of anæmia or jaundice. In many cases, however, the infant may show anæmia or deepening jaundice in the period following transfusion. Serial bilirubin estimations must be carried out at eight or twelve hour intervals if the jaundice deepens and exchange transfusion repeated if the bilirubin level reaches 18 to 20 mg. per cent. The development of

kernicterus is likely if the serum bilirubin exceeds this level. Exchange transfusions may be necessary on two or three occasions within the first four or five days of life. If the umbilical vein thromboses, the catheter can be introduced into the femoral vein through the long saphenous vein, exposed in the upper thigh by a cut down technique.

ABO and other group incompatibilities. Only 90 per cent of the cases of erythroblastosis fœtalis can be demonstrated to be due to rhesus incompatibility and the remainder are due to differences in the ABO, M or N, S, Lu, Kell or Duffy blood groups in the parents.

The most common cause of jaundice due to blood group incompatibility, other than rhesus incompatibility, is that due to ABO factors. This is most commonly seen in group O mothers with group A infants. Jaundice occurs within the first 24 hours and rapidly deepens. Anæmia and splenomegaly are not usually seen and Coombs test is positive in only about 40 per cent of the cases. The diagnosis can be proved by demonstrating that the mother's serum contains a hæmolytic antibody active against the infant's cells. Treatment is indicated if the infant's serum bilirubin level rises to 20 mg. per 100 ml.

Kernicterus. Kernicterus is a condition in which the basal ganglia of the brain are damaged with bile staining in the presence of high serum bilirubin levels. If the infant survives, this neurological damage is shown by extra-pyramidal rigidity, spasticity, deafness and often mental retardation.

The clinical manifestations of developing kernicterus are reluctance to feed, lethargy, increased muscular tone and a tendency to lie in a position of opisthotonus with bulging of the fontanelle.

The condition only occurs in young infants and is caused by an excess of indirectly acting, unconjugated bilirubin in the blood, due to overproduction or to limited ability of the immature liver to conjugate the bilirubin with glucuronic acid. The damage to the basal ganglia is very rare unless the serum bilirubin level exceeds 20 mg. per cent.

CONGENITAL MALFORMATIONS

The cause of congenital abnormalities remains doubtful. Some of these malformations are genetically determined, while others have been attributed to pressure effects associated with the intra-uterine position of the fœtus. A possible cause of congenital defects may be a disturbance in the nutrition or metabolism of the fœtus during the early weeks of intra-uterine life, but the mechanism of such disturbances is little understood. This interference with normal development may be due to placental hæmorrhage, maternal virus infection or other intercurrent

disease. The tissue which is most actively growing at the time when the maternal health is disturbed is most likely to show the congenital defect.

The congenital malformations which may occur in the baby are numerous and varied. The majority of these lesions do not endanger life and may be susceptible to cosmetic surgery at a later date. Some lesions are incompatible with life and there is no treatment which can remedy the defect. The lesions which are important during the neonatal period, therefore, are those which endanger life but which, with prompt intervention, can be remedied. One or two of these conditions will be discussed.

Rubella syndrome. When the pregnant woman develops rubella before the 12th week of the pregnancy, there is a considerable risk that the foetus will show congenital malformations such as congenital cataract, deafness, congenital heart lesions, mental retardation, or microcephaly. The proportion of affected infants in different epidemics has varied from 20 to 50 per cent. The earlier the infection is suffered the greater is the proportion of affected infants. Eye lesions are most common following infection in the first 4 weeks, congenital heart lesions in the 1st and 2nd months and deafness is most common in infections from the 2nd to 4th month. Mental retardation is found in only 1 to 2 per cent of affected babies.

Infection of the pregnant woman with rubella in the first trimester raises the question of termination of pregnancy. (See p. 568.)

Tracheo-œsophageal fistula or atresia. See p. 669.

Intestinal obstruction. See p. 669.

Imperforate anus. This condition will be discovered at the time of the first physical examination or when the rectal temperature is taken. There are several varieties of the condition and the gap between the anal dimple and the blind rectal pouch may be only membrane thick or several centimetres wide. The rectal pouch may open through a fistula into the vagina, urethra or bladder. Investigation must be undertaken to determine which type of lesion is present and surgical opinion sought. It may be possible to restore normal gut continuity at once, or a colostomy is performed and plastic procedures carried out at a later date. A plain X-ray of the abdomen with the patient upside down may show the distance which exists between the gas in the rectum and the anal dimple. This influences the surgical approach.

Anatomical variations in the umbilicus. During early intra-uterine life the cord carried two umbilical arteries, a vein, and the stalks of the yolk sac and the allantois.

The skin *of the abdominal wall invests the base of the cord for a sho*
distance, and, when the cord separates, the skin dimples to form the navel.
If the skin is carried on to the cord for a greater distance than is usually seen,
separation of the cord leaves a protruding cylinder of skin. This is called
a *cutis navel,* but requires no treatment as the skin cylinder is absorbed into
the abdominal wall with growth. It is often mistaken for an umbilical
hernia. When the skin of the abdominal wall does not reach the base of the
cord, a wide raw area is left which heals by granulation and fibrosis—the
amnion navel.

Umbilical sinuses. Persistence of the yolk sac or allantois may cause a dis-
charging sinus at the navel.

Meckel's diverticulum. Meckel's diverticulum may remain only as a
blind sac on the wall of the small gut, or as a fibrous cord with or without
enclosed cysts running between the small gut and the navel, or may form a
fæcal fistula at the umbilicus. Pus or mucoid discharge may give way to
fæcal discharge.

The allantoic remnant may remain as a fibrous cord between the navel
and the apex of the bladder, or as cystic swellings deep to the navel. Some-
times a persistent urachus produces a urinary fistula at the umbilicus.
Surgical treatment is necessary.

A single umbilical artery is found in a small number of infants and is
frequently associated with other congenital abnormalities.

Umbilical hernia. The gap in the rectus sheath through which the
components of the cord enter the abdominal cavity can be palpated as a
ring after the separation of the cord. Normally this ring closes down and
restores the integrity of the rectus sheath. Persistence of the ring may
permit a bulge of peritoneum with mesentery or gut enclosed and is an
umbilical hernia. Surgical treatment may be required in later infancy, but
only after a prolonged trial of expectant treatment. The use of binders,
trusses or coins is never indicated. The association of anæmia and umbili-
cal hernia in cretins should be borne in mind.

Exomphalos. Exomphalos is a congenital defect of the closure of the ab-
dominal wall. The infant is born with a deficient abdominal wall and the
intestines are extruded, usually covered by peritoneum. The condition
usually looks very grave, but, if no other gross congenital defect exists, the
viscera should be covered with sterile dressings and surgical advice im-
mediately obtained. It is often possible to repair the defect if the operation
is performed at once and full antibiotic cover is given.

Hare lip and cleft palate. Failure of mid-line fusion of the premaxilla
and palate may cause a variety of lesions. The upper lip may show clefts
and there may be a mid-line defect of the palate. This may affect only the

soft palate, or may also affect the hard palate. *The cleft may extend for-*
wards and involve the maxilla also. These lesions create difficulty in feed-
ing, either by affecting sucking or by permitting milk to enter the nose and
cause choking. Various shapes of teats with flanges to occlude the palatal
defect have been evolved, but are not entirely successful. Spoon feeding is
often successful, but tube feeding is sometimes essential. It may be neces-
sary to undertake surgical repair at a very early stage, but it is preferable to
delay this until the infant is at least 10 pounds in weight.

Congenital dislocation of the hip. In the newborn infant this usually
exists as a potential dislocation, although rarely actual dislocation is present.
Examination of the hip of the newborn infant for excessive mobility or for
a click felt on full abduction of the flexed thighs is suggestive of disloca-
tion. Early treatment by abduction splints may prevent trouble in later
infancy. Orthopædic advice must be sought immediately in any doubtful
case.

Talipes equino-varus. The intra-uterine fœtal position tends to pro-
duce this deformity which only seldom persists after birth. When true
adduction is present it should always be treated early. Manipulation,
strapping or fixation of the affected part by an orthopædic surgeon is
desirable. Less severe cases may respond to manipulation several times a
day. In either case, treatment must be started at the earliest possible
moment. Talipes calcaneo-valgus may also be seen.

Spina bifida and meningocœle. Failure of fusion of the vertebral
arches permits herniation of the meninges at any level in the spinal
column, usually in the lumbar area. The herniation may be covered by
skin or only by a bluish membranous roof, and the sac may include nerve
roots or spinal cord (meningo-myelocœle). When the skin covering is
defective, the cerebro-spinal fluid may leak and meningeal infection is
frequent. The prognosis is best when there is no evidence of paralysis of the
lower limbs or loss of sphincteric control or anal tone. When skin defects
exist, but there is no paralysis, surgical repair is often attempted. If surgery
is to offer any hope of success, immediate prophylaxis against infection
must be undertaken. No dressing should be applied. A large rubber ball is
cut in two and sterilized. The dome of one half of the ball is placed over the
meningocœle and kept in place by a bandage. The infant is nursed on his
face, full antibiotic cover is given and surgical aid enlisted.

Hydrocephalus. The baby may show enlargement of the head at birth,
or the condition may be present to such a degree as to cause difficulty in
delivery. Hydrocephalus is caused by an obstruction to the normal

circulation of the cerebro-spinal fluid, which is often due t<
abnormality of the brain. The head is large and the sutures and ρ   ·enital
wide. The skull is globular in shape and appears relatively enorm   in
comparison with the small triangular face, with bulging of the forei

FIG. 233.   X-Ray shows typical appearance of hydrocephalus.
Note wide separation of bones of the vault of the skull; also the large size of the
fœtal head in comparison with other fœtal bones.

and above the ears. There is sometimes an associated spina bifida or men-
ingocœle. Some cases are susceptible to neurosurgical treatment, but the
outlook is poor.

Anencephaly. The vault of the cranium and brain are absent. This
deformity is often associated with spina bifida and other malformations. It
is incompatible with life. An anencephalic fœtus presents either by the face
or breech.

ɔngenital heart lesions. Exact diagnosis and prognosis is particularly ᵢᴄult at this age. (See p. 640.)

FIG. 234.   Anencephaly.
Note the absence of the vault of the fœtal skull.

INFECTION IN THE NEWBORN INFANT

The newborn infant has a low natural resistance to infection and may succumb to infections which are of low pathogenicity to adults, the organisms being carried by attendants who have themselves no symptoms. For this reason, carriers of streptococci in the throat or individuals suffering from low grade staphylococcal infections or head colds represent a great potential danger to infants in their care.

The response to infection which is shown by the newborn infants is very different from that shown by older children. The symptoms which denote neonatal infection are seldom local, but are general and merely indicate a general deterioration in health. It must be emphasized that the onset of many serious infections in the newborn infant is often insidious, and the infection may be well established before it is realized that the infant is gravely ill.

Some degree of vomiting and diarrhœa is commonly seen in infants suffering from infection which is remote from the gastro-intestinal tract. Anorexia or refusal to feed is a common early symptom in generalized infection; lethargy and sleepiness are frequent.

The temperature response to infection is seldom marked and quite a severe infection may cause a rise in temperature of only $1°F$. Very severe infections may sometimes cause a subnormal temperature, slow pulse-rate, reduced respiration-rate, marked sleepiness and collapse without localizing signs. Tachycardia is often a more important sign than fever.

The symptoms do not always point to the site of the infection and the general signs and symptoms which indicate that infection has occurred necessitate a careful clinical search for the lesion. Frequently the aid of the laboratory is required to localize the infective process. Examination of the urine, throat or umbilical swab, blood-culture and sometimes lumbar puncture may be necessary to determine the nature of the infection, and should be carried out when a diagnosis of infection is made but there are no localizing signs.

Respiratory tract. *Head cold and nasal catarrh.* When a young infant contracts a cold in the head, the secretions in the nose may cause embarrassment during feeding and the infant may be snuffly and fretful at this time. The real danger to the infant lies in the normal resting position of the infant on his side or on his back. The infected secretions drain down the back of the throat and with the poor cough reflex of the infant may pass the barrier of the larynx and cause an infection of the lung.

Otitis media. The same anatomical considerations affect the middle ear, and the relatively wide and straight Eustachean tube permits an easy channel for ascending infection, infected secretions or vomited material. The symptoms are those of low grade fever, irritability and general malaise, and the infection is found only on full routine physical examination of the infant. Examination of the tympanic membranes is an essential part of the routine examination of the ill baby. Spread of the infection to the mastoid air cells is relatively easy, and meningeal infection may follow by spread of infection through the spongy bone or by the veins.

Early diagnosis and the appropriate antibiotic therapy are essential; myringotomy and mastoid operations are carried out when indicated.

Pneumonia. Primary pneumonia is rare, and the infection is usually a descending spread from the upper respiratory tract to the lung which has already shown a mechanical lesion such as atelectasis, or a lesion caused by the inhalation of mucus, food or vomitus.

Cough is an uncommon symptom in infancy and attention is usually drawn to the disease by a rising respiration-rate, cyanosis, pallor or a slight rise in temperature, associated with anorexia and general malaise.

Examination of the chest may show little that is abnormal, and alterations in percussion note and air entry are hard to determine. The presence of showers of fine râles is the abnormality most frequently detected and may represent the sum total of the physical signs.

The essentials of treatment are to maintain full oxygenation, which usually requires an oxygen tent, to ensure an adequate fluid intake, and the use of the appropriate antibiotic. Nose and throat swabs should be taken to isolate the offending organism and to determine the sensitivity to antibiotics.

Pyothorax. This may complicate pneumonia, especially when a staphylococcal infection is present.

Gastro-intestinal infections. These have been discussed elsewhere (p. 674).

Mouth. Infection of the buccal mucous membrane and the tongue by thrush is not infrequent in bottle fed or debilitated infants. The fungus (*Candida albicans*) grows in the mucous membrane of the mouth and shows as greyish-white plaques and shreds which resemble milk curds, but which cannot be wiped off with gauze. The constitutional upset is usually slight, but the soreness of the mouth during the invasion stage and before the lesions are easily seen, may cause the infant to refuse feeds. Rarely, the fungus infection spreads down the gastro-intestinal tract and causes œsophagitis, gastritis or enteritis; occasionally sore buttocks may be caused by thrush. During antibiotic therapy the lungs may be involved by the fungus, which multiplies under cover of the antibiotic in the absence of the normal bacterial flora.

The fungus is frequently present before delivery in the vagina of pregnant women and this may be the source of infection.

Treatment is by the local application of nystatin 100,000 units in 1 ml. of solution, which is swabbed around the mouth four times daily. The application of 1 per cent gentian violet in aqueous solution twice a day or merthiolate 1: 10,000 are less effective. These lotions should be applied with a wool swab on a stick rolled over the affected mucous membranes.

Infection of the urinary tract. This is at least as common in the male newborn infant as in the female. Symptoms suggestive of infection without

physical signs should always promote a search for infection of the renal tract. The culture of a clean specimen of urine in the newborn infant often shows coliforms, *Streptococcus fæcalis* and infrequently *B. pyocyaneus* or *B. proteus*. This finding should not be taken as evidence of renal tract infection unless pus cells are also found in the urine. Renal tenderness is seldom found, and the predominant symptoms may be diarrhœa, vomiting and reluctance to feed. The temperature may only be slightly elevated or show a rise of two or three degrees.

Pyelonephritis may be due to an ascending infection or may come from a blood borne infection.

It has recently been demonstrated that many infants with pyelonephritis suffer from a congenital malformation of the renal tract causing some degree of obstruction or ureteric reflux. These infections are stubborn in resistance to treatment which should always be of several weeks duration. Intravenous pyelography is frequently indicated in the investigation of even one attack of pyelonephritis.

Treatment demands a full course of the appropriate antibiotic.

Septicæmia. This is not uncommon in the newborn infant, following cutaneous or umbilical infection. The general symptoms of infection with fever, splenomegaly and urinary changes indicate the diagnosis. Blood-culture should always be carried out at the earliest suspicion.

Osteomyelitis. Infection of the long bones or maxilla is a complication of infection with staphylococci, usually arising from cutaneous or umbilical infection. Initially the symptomatology is that of a general systemic infection with low grade fever, followed by reluctance to use a limb, redness and swelling over the affected bone and occasionally the development of a septic arthritis in a contiguous joint. Full antibiotic treatment and orthopædic advice on the drainage of pus is essential.

Meningitis. Infection of the meninges seldom presents in classical form and may be present without definite physical signs. Lumbar puncture is always justified when signs of infection are present without localizing symptoms or signs. Coliform bacilli are often responsible for meningitis at this age, but any of the common bacteria may be found.

Skin sepsis. A small pustular eruption due to staphylococcal infection is the type of skin sepsis which occurs most commonly in the newborn infant. The soft and moist skin of the infant is easily traumatized by clothing or rubbing with the towel after the bath. The infecting organism may be present in the nose or on the skin of nurses or doctors, or may be transferred from other infected babies. The napkin area is moist and is

often the initial site of the infection. The danger of staphylococcal infection of the skin is greatest when the area around the raw umbilical site is involved.

Pemphigus neonatorum is a bullous or vesicular eruption in the skin with large fluid-containing blisters which raise the outer skin layers. The epithelium covering the vesicle is easily rubbed off leaving a raw area which can easily become secondarily infected. Pemphigus may be due to congenital syphilis, but is more commonly streptococcal or staphylococcal in origin. In syphilitic pemphigus the palms of the hands and the soles of the feet are involved and often signs of congenital syphilis are present.

In pyogenic pemphigus the lesions may spread and produce an exfoliative dermatitis with the major part of the body surface denuded of epithelium. The infant shows severe toxaemia, and the condition carries a grave prognosis.

Erysipelas may occur and often starts as a streptococcal infection at the ubilicus which spreads over the abdominal wall.

Skin infection usually requires the appropriate antibiotic treatment and it is usually wise to administer this systematically. Local applications may produce sensitization rashes. When possible, a swab should be taken for identification of the organism and for sensitivity tests, especially in staphylococcal infections.

Infections of the eye. A purulent conjunctivitis with profuse discharge usually occurs during the latter part of the first week of life. The organism is usually a staphylococcus, but diphtheroids may also be found. A certain proportion of such infections show no organism on culture.

The palpebral conjunctiva is usually affected and is red and œdematous. The swelling of the lids may cause difficulty in examination of the eye, and in treatment.

A swab must be taken for culture and sensitivities before treatment is started. Albucid drops of 10 per cent strength may be used 3 times a day, or penicillin eye drops (2,500 units per ml.) used instead. Penicillin eyedrops may be used 4-hourly or a concentrated course may be given. In cases which are penicillin resistant, 1 per cent aureomycin eye ointment or 0·4 per cent chloramphenicol drops may effect a cure.

Apart from the use of eyedrops, the only local treatment which is required is to wipe the palpebral fissure clear of discharge with a wool swab soaked in normal saline. The infection usually clears within a few days under treatment.

Dacrocystitis. Blockage from failure of canalization of the naso-lachrymal duct causes spilling of tears from the eye, a sticky eye usually indicating a superadded infection. Pus may sometimes be expressed from the duct by pressure in the angle between the inner canthus and the nose. Gentle

massage of this area with the tip of the little finger several times a day in addition to local antibiotic therapy will usually clear the infection, but the massage should be continued for several months before probing of the duct is undertaken by an ophthalmic surgeon.

General treatment of infection of the newborn

Three main principles of treatment must be observed. 1. The general condition of the infant must be maintained and alterations made in the feeding routine to suit the needs of the infant. A change to a more dilute or more easily digested feed may be necessary. In severe infections expressed breast milk is of great value if it can be obtained. When the infant tires easily or becomes exhausted with a large or lengthy feed, feeds may be given in smaller amounts at shorter intervals. Care should be taken to ensure that the total daily intake is sufficient for the infant's needs and compensates for any unusual losses by diarrhœa.

When the infant is unable to take adequate fluid by mouth, it may be necessary to supplement this by intravenous infusions.

When anæmia occurs during an infection, great benefit may be derived from a small transfusion of 50 to 100 ml. of fresh blood.

2. Full oxygenation must be maintained and the temperature kept within reasonable level by the application of warmth, or cooling if hyperpyrexia is present.

3. Control of the infection by the use of the appropriate antibiotic. The range of bactericidal drugs is very wide and, if the organism which is causing the infection is known and the sensitivity has been determined, the correct drug for the individual can be employed.

The newborn infant may show responses to antibiotics which do not occur in older individuals and care to ensure the correct dosage may be of the greatest importance.

Sulphonamides of the long acting type may compete with bilirubin for the plasma albumin and may therefore uncouple bilirubin and render it more diffusible through the blood brain barrier with an increased risk of kernicterus.

Chloramphenicol is rapidly absorbed and is cleared from the body by renal tubular excretion, conjugated to the glucuronide. Since glucuronide conjugation is at a low level in the early days of life there may be accumulation of the drug in the body. Newborn or premature babies may show collapse and hypothermia after high dosage treatment with chloramphenicol and show the 'grey-baby syndrome'. The drug must therefore be used with great discretion.

Streptomycin is effective against a great variety of neonatal infections. It is scarcely absorbed from the gut and must be given by intramuscular

injection in systemic infections. Nerve deafness is seldom seen if the course of treatment does not exceed 7 days, but if high dosage is given infants may show stupor, respiratory depression and muscle flaccidity.

Tetracycline given to premature or newborn infants may cause yellow staining of the deciduous teeth. There have been reports of disturbance of bone growth following the use of this drug.

In the newborn infant it is not desirable to await the results of the laboratory investigations, which will take at least 48 hours, before initiating treatment. It is essential that empirical treatment should be begun as soon as the signs of infection have been detected and the antibiotic which is most likely to overcome the infection should be given in suitable dosage.

The dosage of the different antibiotics which is used during the neonatal period is very wide, but the following dosage is appropriate:

Drug	Route	Dosage
Penicillin	Oral	62·5 mg. 6-8 hourly
	I.M.	50,000 units 6 hourly
Cloxacillin	Oral	62·5 mg. 6 hourly
(Orbenin)	I.M.	62·5 mg. 6 hourly
Methicillin	I.M.	125-250 mg. 8 hourly
(Albenin)		
Ampicillin	Oral	62·5-125 mg. 6-8 hourly
Streptomycin	I.M.	5-7 mg./kg./day in 2-3 doses
Tetracyclines	Oral	12-25 mg./kg./day in 2-3 doses
	I.M.	10-15 mg./kg./day in 2-3 doses
Chloramphenicol	Oral	12-25 mg./kg./day in 3 doses
	I.M.	5-10 mg./kg./day in 3 doses
Neomycin	Oral	12 mg./kg./day in 3 doses

THE UMBILICUS

The residual stump of the umbilical cord desiccates and separates, usually by the 7th day, and leaves a raw area which heals by granulation. Until healing is complete the umbilicus represents an open wound which by its proximity to the napkin area may easily become infected.

Umbilical granulation. When low grade infection of the navel is present, granulation tissue may require treatment by cauterization with silver nitrate or antibiotic treatment locally.

Umbilical stickiness and moistness. This is seen immediately after the cord separates and is best treated by applying a hibitane dressing or painting with 1 per cent aqueous solution of gentian violet.

Umbilical infection. Infection with a virulent organism may cause a spread of infection along the umbilical vein to the blood-stream with septicæmia, pyæmia, hæmolytic anæmia and jaundice. The infant becomes ill and shows general signs of infection, often with enlargement of the liver and spleen. The slightest suspicion of umbilical infection which has become generalized demands urgent treatment. A swab from the navel and a blood-culture to establish the nature and sensitivities of the infecting organism should be followed at once by full antibiotic therapy. The prognosis is serious.

Umbilical hæmorrhage may follow a slipped ligature or occur when the cord separates. Immediate religature is required and transfusion if the blood loss exceeds 50 ml.

VARIOUS ABNORMALITIES IN THE NEWBORN INFANT

Dehydration (inanition) fever. Fever during the first week of life is often present without any evidence of infection. Dehydration fever may occur between the third and fifth days of life and the temperature usually reaches 100° to 101°F, although it may rise as high as 105°F and the infant become collapsed. The usual signs of dehydration are absent but the mouth and tongue are dry and the skin feels hot and is powdery.

The day on which fever appears usually coincides with the day of maximal weight loss. The condition is treated by giving the infant boiled water to drink by spoon in amounts of 1 ounce hourly until the temperature reaches normal. Occasionally it may be necessary to give a rectal or subcutaneous infusion.

The infant of the diabetic mother. The infants of women suffering from diabetes, even when the disease is well controlled by diet and insulin, have a high incidence of intra-uterine death after the 36th week of gestation and show an increased neonatal death rate. The infants of pre-diabetic mothers show similar but lesser risk rates.

The infants tend to be larger than expected from the gestational age (macrosomia) and are plump and plethoric. The face and body tend to be œdematous. Cyanotic attacks, the respiratory distress syndrome and twitching attacks are common. Hypoglycæmic and hypocalcæmic episodes occur.

Despite their size these large infants of diabetic mothers behave like premature babies and require the treatment for a small immature infant. The use of incubators with high humidity and extra oxygen is required. Hypocalcæmia and hypoglycæmia may require treatment and early feeding with extra glucose may be helpful.

Laryngeal stridor may accompany inspiration in some newborn babies. It is worse with crying and quietens when the baby is asleep. There is often indrawing of the lower ribs and suprasternal notch. The cry is normal. The cause of the condition is debatable but it is usually attributed to congenital narrowing or smallness of the larynx, infolding of the epiglottis during inspiration, or to thymic enlargement. Laryngeal polyp or web is very rare but when doubt exists as to the cause direct laryngoscopy will often clarify the diagnosis. Unless a true obstructive lesion is present in the larynx there is no indication for treatment and the condition has usually resolved by the time the infant has reached the age of 18 months.

Mongolism (Down's syndrome). The condition may often be diagnosed immediately after birth by the characteristic appearance. The infant has a flat face with slanting eyes, epicanthic folds, a snub nose and often a protruding tongue. The head is round with a poorly developed occiput and unusual ears. The posterior and third fontanelle are easily palpable. The infant is hypotonic and the joints over-extensible, while the hands may show a transverse 'four finger' palmar crease and the soles of the feet have a simian cleft between the great toe and the next toe. An umbilical hernia and congenital heart disease may be detected.

Mongolism is caused by an abnormality of the chromosomes. The majority of these infants born to mothers over the age of 35 years have 47 chromosomes instead of 46 and the extra chromosome is an autosomal trisomy due to non-disjunction of chromosome 21. A small proportion of affected infants have a normal chromosome count but show an unduly large chromosome, probably number 15, which incorporates part of an extra chromosome number 21, due to a translocation.

The incidence of the syndrome is 1·5 to 2 per 1,000 births but the incidence of the translocation defect is many times greater. The incidence of mongolism rises sharply with increase in maternal age and may be as high as 1 in 50 when the maternal age is over 40 years. Chromosome studies should be undertaken when a young mother gives birth to an affected infant. The demonstration of a translocation of chromosome 21 indicates a greatly increased possibility of a second mongol in later pregnancies.

The male genital system. Delay in passing urine after birth may be seen for periods up to 24 hours and is usually not of pathological significance. Pressure above the symphysis pubis often results in the passage of urine. The first specimen often has a pinkish colour which is due to a high concentration of urates.

Abnormalities of the meatal orifice are seen, and all degrees of hypospadias and epispadias may be met. In the milder degrees of hypospadias it may be thought that the meatal orifice is not patent, but a careful search will

reveal a minute orifice on the ventral surface of the corona or shaft of the penis through which urine is voided. In cases in which doubt exists, the patency of the meatal orifice, normal or ectopic, can be verified by the introduction of a sterile, well lubricated sound or catheter.

Hydrocœle may occur in the neonatal period, but requires no special treatment as the condition usually resolves spontaneously within a few days or weeks.

Circumcision. This may be a ritual or a surgical operation. Ritual circumcision is practised in Jewish infants and is usually performed on the 8th day. It is sometimes necessary, to advise that the operation should be postponed if the infant is ill, jaundiced, or shows undue loss of weight. It is wise to maintain a close watch for hæmorrhage for the 12 hours following the circumcision, which is not always performed by the usual surgical technique.

Non-ritual circumcision is not practised so frequently nowadays as it was in the past. Opinion as to the desirability of the operation is very widely divergent and the wishes of the parents often dictate whether the operation is carried out. Circumcision is rarely indicated on medical grounds when phimosis is present in sufficient degree to embarrass micturition.

Routine retraction of the foreskin in the first week of life and the separation of preputial adhesions has been advised. If this is performed with too great zeal the prepuce may be torn and may bleed. In practice it is sufficient to ensure that urine can be passed without pain and otherwise no interference is necessary.

The female genital system. *Pseudohermaphroditism.* In these infants the gonads are ovaries but the external genitalia are masculinized. This is commonly due to congenital adrenal hyperplasia but may occur when the mother has received high dosage of progestational compounds for threatened abortion. The clitoris is enlarged and partial or total labial fusion is present. Sex chromatin is positive in buccal mucosal smears or polymorphonuclear cells.

Labial adhesions. The external genitalia may appear abnormal due to adhesions between the labia minora obscuring the urethra and vaginal orifice. The adhesions are easily broken down by simple stretching apart of the labia.

Placental dysfunction syndrome (Placental insufficiency). (See p. 241.) The syndrome with yellow staining of the vernix and skin of the infant is seen in about one per cent of births, about one fifth of these infants are postmature. The remainder occur in premature births, infants of toxæmic mothers or where the placenta is small.

The infants are often small with the appearance of undernourishment,

with loose skin which may be yellow stained. The body length is usually long in proportion to the degree of nutrition. The infants are susceptible to respiratory distress and metabolic disturbances but usually make rapid progress once feeding is properly established.

Postmaturity. (See p. 67.) There is a considerable risk to the infant from postmaturity and a significant increase in the neonatal mortality. The infant has a mature appearance similar to an infant 1 or 2 weeks of age, with pale skin, abundant hair, long nails, absent lanugo and increased alertness. The skin may be dry and parchment-like. These variations from normal disappear as the infant grows.

Neonatal cold injury. These babies present with apathy, refusal to feed, oliguria and coldness to touch. The babies look a good colour, usually bright pink, but there is immobility, œdema of the hands and feet and a firm texture to the subcutaneous fat. The rectal temperature may be 80° to 90°F, respiration is slow and a marked bradycardia is present. The condition occurs when the environmental temperature is very low, usually freezing out of doors. Infection is often present and the condition may be due to an abnormal response to low environmental temperatures in infectious states. Treatment demands very slow warming to a normal body temperature with slow intravenous therapy with glucose. Antibiotic cover should be provided.

Neonatal convulsions. Convulsions occur not infrequently in newborn infants, especially those born by difficult delivery or prematurely. These convulsions may be caused by intracranial trauma, hæmorrhage or œdema, or may be associated with a metabolic disturbance such as hypoglycæmia or hypocalcæmia.

Hypoglycæmia. This may occur in the infants of diabetic mothers but is seen also in premature infants, toxæmia of pregnancy, infants of low birth weight due to multiple pregnancy or placental insufficiency.

Symptoms appear from a few hours after birth to the end of the first week, and the infant may show tremors or twitching, convulsions, eye rolling, apathy, refusal of feeds, or may have apnœic spells.

True blood glucose levels are very low and treatment with 10 per cent glucose solution by intravenous infusion must be started, followed by oral glucose, if necessary by indwelling gastric tube. Hydrocortisone 5 mg. every 6 hours may be helpful in maintaining adequate blood glucose levels. Death may occur during these attacks, or the infant may survive to show mental damage as a consequence of the low brain glucose levels. With early recognition and treatment of the condition spontaneous recovery takes place within a few days.

Hypocalcæmic attacks. The infant shows twitching, increased muscular tone, and often vomiting. Neuro-muscular irritability may be found. The condition is proved by the demonstration of a low serum calcium and is treated by the intravenous administration of 10 per cent calcium gluconate solution, followed by oral administration of calcium lactate 1 G. three times a day for one week.

Inborn errors of metabolism. Many of the inborn-errors of amino-acid and carbohydrate metabolism are not detected until after the end of the new-born period. Galactosæmia.and phenylketonuria deserve mention as their early detection leads to dietary measures which may reduce the ill effects of the condition.

Phenyl-ketonuria. This inborn error of amino-acid metabolism is an inability to convert phenylalanine to tyrosine, and is inherited as a recessive characteristic. The dietary phenylalanine accumulates in the tissues and is excreted in the urine, partly broken down to phenylpyruvic acid and similar products.

The saturation of the tissues with phenylalanine causes mental deterioration which is progressive. The infant may appear physically normal but often appears strikingly blonde with blue eyes. Deterioration appears as the infant grows and the toxic effects are seen as phenylalanine and phenylpyruvic acid accumulate in the body.

Phenylpyruvic acid may be detected in the urine by the ferric chloride test which gives a green colour in the urine or by the use of Phenistix. The test does not usually become positive until after three weeks of age, but all infants should have a routine urine test.

Treatment with a phenylalanine free diet slows the deterioration seen in these infants and has been claimed to prevent gross mental retardation if started in early infancy.

Galactosæmia arises from a congenital defect in the metabolism of galactose derived from the lactose in milk. It is inherited as a recessive trait and causes retardation of growth and development. Lack of the enzyme galactose-l-phosphate uridyl transferase prevents the conversion of galactose to glucose-l-phosphate, which is an essential step if galactose is to be utilized by the tissues. Galactose accumulates in the body and appears in the urine as a reducing substance. The affected infant appears normal at birth but listlessness, vomiting, anorexia and weight loss may soon appear. The infant shows jaundice, hepato-splenomegaly and evidence of portal obstruction. Cataracts may develop at an early stage. Mental retardation and cirrhosis of the liver develop in the untreated case.

Treatment of the condition consists of the withdrawal of all dietary lactose, and feeding synthetic milks which are galactose free. Early institution of treatment will cause disappearance of the abnormal physical findings.

Bilateral renal agenesis (Potter's syndrome). Bilateral renal agenesis is usually associated with oligohydramnios. The infant with bilateral renal agenesis looks prematurely senile with wide set eyes, flattened nose, a receding chin, and low set ears. The facies is strongly characteristic. The prognosis is hopeless and the infant usually dies within the first few days.

THE PREMATURE INFANT

The premature infant should logically be defined as a baby born before the end of the normal period of gestation. However, some full-time infants are small and immature and are subject to the same hazards to life as the prematurely born baby. A conventional standard of prematurity (and immaturity) has been adopted and all babies of a birth-weight less than $5\frac{1}{2}$ pounds (2,500 g.) are included in this classification.

These babies, by reason of their immaturity, are especially liable to suffer from intracranial hæmorrhage, infection, atelectasis and respiratory arrest, and difficulties in feeding.

The fœtus is legally viable after the end of the 28th week of pregnancy, but with modern methods of treatment infants weighing as little as $1\frac{1}{2}$ pounds may survive.

Mortality-rate in premature birth. The survival rate in premature babies is related to the cause of prematurity, the duration of pregnancy and most especially to the birth-weight. The resources available for treatment will influence survival most significantly. Premature birth due to toxæmia or maternal illness diminishes survival rates, and in general the smaller the baby the less the chance of survival. The immature skull and poorly developed blood-vessels of the smaller babies increases the risk of intracranial hæmorrhage even when labour is uncomplicated.

General principles of treatment

1. To maintain body temperature.
2. To avoid infection.
3. To maintain adequate oxygenation.
4. To establish nutrition.

Babies weighing between $4\frac{1}{2}$ to $5\frac{1}{2}$ pounds at birth can be nursed satisfactorily at home, but the infant below $4\frac{1}{2}$ pounds is usually given a better chance of survival under institutional care. In many areas premature baby centres have been established for this purpose, and on request a specially equipped ambulance and trained nurses will be sent out to transport the baby to the centre.

The past few years have brought very radical changes in the technique of care of the premature infant. The realization that these infants require a high humidity in the atmosphere, great freedom of movement to maintain vigour, and that they do not need early and full feeding, represent the major advances in technique. The use of antibiotics to combat infection has also lowered the mortality.
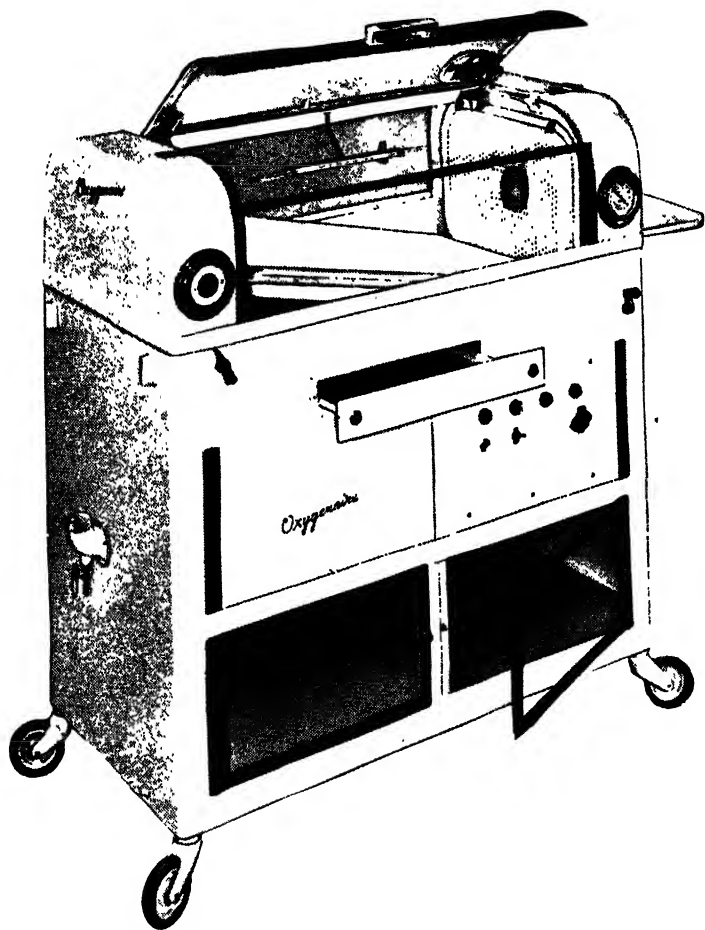
[Oxygenaire, Ltd.

FIG. 235. Oxygenaire incubator for premature baby.

Home nursing should aim at reproducing in so far as possible the technique of the premature nursery, modified by circumstances and according to the weight of the baby.

Institutional regime for premature infants. As soon as respiration has been established, the infant should be placed in an incubator. Various types of incubators are available, but nearly all permit regulation of the internal atmospheric temperature, humidity and oxygen concentration. The infant is placed in the incubator quite naked and lying on a napkin. The incubator temperature is adjusted to a level which will keep the infant's temperature above 97°F. A humidity of 70° is desirable at first and oxygen is supplied as required. It is best that the oxygen concentration should be the lowest which will prevent any cyanosis and that oxygen administration is for as short a time as is essential. Phytomenadione (vitamin K_1, Synkavit) 0·5 mg. is given by injection, and intramuscular penicillin is a valuable prophylactic during the first few days of life.

In the incubator the infant can be kept under observation and the respiratory passages immediately cleared of mucus if this should become necessary. All nursing services must be carried out by individuals wearing gown and mask. The premature infant in an incubator shows remarkable activities and moves the legs and arms, and indeed the whole body, in a very free manner. The older technique of wrapping the infant in close swaddling blankets and shawls to maintain body heat hampers free chest and limb movements and diminishes respiratory and vascular function. The nudist technique in the incubator encourages the development of muscle tone and full expansion of the lungs.

Some years ago it was believed that the premature infant, because of low birth-weight and precarious hold on life, should be fed at an early stage and the feeds worked up to a high caloric intake as soon as possible.

The smaller premature infants have poorly developed sucking and swallowing reflexes and regurgitate food easily. Many deaths from inhalation of regurgitated feeds must have occurred through feeding too soon after birth and before the baby was ready.

[John Bell & Croyden.

FIG. 236.   The Belcroy feeder.

Recently it has been shown that small babies can be left in incubators without feeds until the baby himself shows that he is ready and eager for food. The interval between birth and first feeding may be as long as 24 to 100 hours. It has been said that 'the infant should be left until his cries for food soften even the heart of a maternity ward sister'. By the time he is ready to take food the muscle tone has improved and the liability to regurgitation has greatly diminished.

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When feeding is started, a trial with a few drops of sterile water from a pipette should be made. Larger premature infants can both swallow and suck; smaller babies may be able to swallow but not suck; and the smallest infants of all can do neither. If swallowing and sucking are both absent, then tube feeds are necessary. The smaller premature infants may be fed through a fine polyvinyl catheter passed through the nose into the stomach and left in situ. Frequent small feeds can be given with minimal disturbance to the infant. When the infant can swallow but not suck, then feeds with a fountain pen filler will be satisfactory. Larger babies will take from a Belcroy feeder or from a bottle.

Feeds should be small and frequent and 2-hourly feeding may occasionally be required at first, but with increase in the size and strength of the baby, the size of feed and interval between feeding may be increased to 3-hourly.

The first feeds may be of 5 per cent glucose and then a dilute milk feed is given. Expressed breast milk affords the most satisfactory feed, but dried milks or evaporated milks may be used.

Experience in the nursing of premature infants alone will teach when the infant can safely be dressed and removed from the incubator, but each advance must be made gradually. From the incubator the infant should be moved to a warm nursery and then to a cool nursery.

Further details of the institutional nursing of premature infants should be sought in specialized textbooks.

Jaundice in the premature infant. The premature infant may show severe physiological jaundice due to liver immaturity. The serum bilirubin level may rise well above 20 mg. per cent between the fourth and seventh days of life and there is a great risk of kernicterus developing. The serum bilirubin level must be estimated and exchange transfusion may be required to keep the serum bilirubin under 20 mg. per cent.

Home care of the premature infant. When there is no special nursery available with temperature, humidity and oxygen under mechanical control, it is necessary to improvise.

An ordinary cot, well padded around with blankets and with a screen around the head of the cot will serve instead of the incubator, and the temperature of the cot can be maintained by hot water bottles which are kept away from the infant by at least one layer of blankets.

The room temperature should be kept at about 75°F. by electric fires, steam radiators, or even a coal fire. The humidity may be kept reasonably high by hanging a damp towel over a steam radiator or in front of an electric or gas fire. The source of heat evaporates the moisture from the towel and

moistens the atmosphere. The process may be made continuous by dipping the corner of the towel in a bowl of water.

Oxygen can be given during cyanotic attacks through a funnel placed over the face, or an oxygen tent may be hired in the larger cities.

It is essential to prevent infection and it is usually wise to keep visitors away from the infant until satisfactory progress has been established. The nurse or individual caring for the baby should wear a mask and, if possible, a gown when handling the infant.

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Note: Figures in italics indicate illustrations; figures in bold type indicate main references.